MAY 6 1924

TRANSACTIONS
OF THE
AMERICAN FISHERIES SOCIETY

FIFTY-THIRD ANNUAL MEETING

ST. LOUIS, MISSOURI

SEPTEMBER 17, 18, 19, 1923

TRANSACTIONS

OF THE

American Fisheries Society

FIFTY-THIRD ANNUAL MEETING

ST. LOUIS, MISSOURI

SEPTEMBER 17, 18, 19, 1923

Published Annually by the Society

HARTFORD, CONNECTICUT

1923

Amer. Fisheries Soc.
9T.
5-2-1924

American Fisheries Society

ORGANIZED 1870 INCORPORATED 1910

Officers for 1923-1924

President ..... GEO. C. EMBODY, Ithaca, N. Y.
Vice-President ..... EBEN W. COBB, Hartford, Conn.
Executive Secretary ..... JOHN W. TITCOMB, Hartford, Conn.
Recording Secretary ..... FLOYD S. YOUNG, Chicago, Ill.
Treasurer ..... T. E. B. POPE, Milwaukee, Wis.

Vice-Presidents of Divisions

Fish Culture ..... C. F. CULLER, Homer, Minn.
Aquatic Biology and Physics, DR. EMMELINE MOORE, Albany, N. Y.
Commercial Fishing ..... JOHN N. COBB, Seattle, Wash.
Angling ..... DUDLEY BERWICK, New Orleans, La.
Protection and Legislation ..... W. E. ALBERT, Des Moines, Iowa.

Executive Committee

CHARLES O. HAYFORD, *Chairman* ..... Hackettstown, N. J.
MAX D. HART ..... Richmond, Va.
EDWARD E. PRINCE ..... Ottawa, Canada
LEE MILES ..... Little Rock, Ark.
GEORGE SHIRAS, 3d ..... Washington, D. C.
E. T. JUDD ..... Cando, N. D.

Committee on Foreign Relations

F. C. WALCOTT, *Chairman* ..... Norfolk, Conn.
W. C. ADAMS ..... Boston, Mass.
R. E. FOLLETT ..... Detroit, Mich.
WARD T. BOWER ..... Washington, D. C.

Committee on Relations with National and State Governments

NATHAN R. BULLER, *Chairman* ..... Harrisburg, Pa.
E. T. D. CHAMBERS ..... Quebec, Canada.
CARLOS AVERY ..... St. Paul, Minn.
HENRY O'MALLEY ..... Washington, D. C.
W. E. BARBER ..... Madison, Wis.

Special Pollution Committee

NATHAN R. BULLER, *Chairman,* to select other members.

Editorial Board

RAYMOND C. OSBURN ..... Columbus, Ohio.
G. C. EMBODY ..... Ithaca, N. Y.
DR. EMMELINE MOORE ..... Albany, N. Y.
JOHN W. TITCOMB ..... Hartford, Conn.

Page

Officers 3

PART I—BUSINESS SESSIONS

Registered attendance 7
Report of Executive Secretary 8
Report of Treasurer 10
Reports of Vice-Presidents of Divisions 13
Appointment of Committees 13
Reports from Corresponding Members 14
Report of Special Committee on Executive Secretary 16
Report of Committee on Nominations 17
Report of Committee on Resolutions 18
In Memoriam 23

PART II—PAPERS AND DISCUSSIONS

Natural and Artificial Conditions Detrimental to Black Basses. *Raymond C. Osburn* 27
The Sportsmen's League. *Fred J. Foster* 50
Museum Methods in Relation to the Fisheries Society. *T. E. B. Pope* 55
Are We Maintaining the Supply of Whitefish in Lake Erie? *S. W. Downing* 62
The Future of the Fisheries of the Pacific. *John N. Cobb* 65
A Report of Progress on the Study of Trout Diseases. *Dr. Emmeline Moore* 74
Pike-Perch Propagation in Northern Minnesota. *Eben W. Cobb* 95
Headwaters. *F. E. Hare* 106
Present Status of the Louisana Shrimp Industry. *E. A. Tulian* 110
Some Considerations Concerning the Canning of Sardines. *Harry R. Beard* 122
Problems in Bass Culture at the Cold Spring Georgia Station. *Charles A. Bullock* 131
Foods and Feeding of Fishes, a Symposium 137
Fish Distribution of the Federal Government. *E. C. Fearnow* 160
Production of the Fresh Water Mussel. *H. L. Canfield* 171
Angling, Past, Present and Future. *Dr. James Alexander Henshall* 176
Notes on the Propagation and Distribution of Pond Fishes. *G. W. N. Brown* 184
Planting Eyed Salmon and Trout Eggs. *C. W. Harrison* 191
Black Bass vs. Netting Coarse Fish. *J. P. Snyder* 201
Fisheries in Virginia. *McDonald Lee* 207
Conservation of the Fishery Resources of the Pacific. *Dr. Barton W. Evermann* 210

PART I

BUSINESS SESSIONS

PROCEEDINGS

of the

American Fisheries Society

FIFTY-THIRD ANNUAL MEETING

at

ST. LOUIS, MISSOURI

September 17, 18, 19, 1923.

The Fifty-third Annual Meeting of the American Fisheries Society convened at the Hotel Statler, St. Louis, Missouri, on Monday, September 17th, at 10 o'clock a.m., President Glen C. Leach, of the Bureau of Fisheries, Washington, in the Chair.

First Session, Monday Morning, September 17, 1923.

President Leach introduced Mr. Findly, Secretary to the Mayor of St. Louis, who delivered the address of welcome.

Mr. Carlos Avery, of St. Paul, Minnesota, made the response.

Registered Attendance

The registered attendance, 58, was as follows:

Acklen, Col. Jos. H., Nashville, Tenn.
Adams, William C., Boston, Mass.
Albert, W. E., Des Moines, Ia.
Amsler, Guy, Little Rock, Ark.
Avery, Carlos, Minneapolis, Minn.
Barber, W. E., Milwaukee, Wis.
Baskett, Cecil M., St. Louis, Mo.
Beard, Harry R., San Pedro, Calif.
Berg, Geo., Indianapolis, Ind.
Berwick, Dudley, Baton Rouge, La.
Bower, Ward T., Washington, D. C.
Brown, Dell, Mammoth Springs, Ark.
Brunson, J. H., Helena, Mont.
Buller, C. R., Pleasant Mount, Pa.
Buller, N. R., Harrisburg, Pa.
Bullock, Chas. A., Bullockville, Ga.
Burnham, C. W., Louisville, Ky.
Canfield, H. L., Homer, Minn.
Catte, Eugene, Langdon, Kansas
Cobb, Eben W., Hartford, Conn.
Culler, C. F., Homer, Minn.
Davies, David, Tupelo, Miss.
Dennig, L. E., St. Louis, Mo.
Downing, S. W., Put-In-Bay, Ohio.
Doze, J. B., Pratt, Kansas.

EHRHART, W. C., St. Louis Mo.
EMBODY, G. C., Ithaca, N. Y.
FEARNOW, E. C., Washington, D. C.
FLEMING, JOHN H., Syracuse, Ind.
FOLLETT, R. E., Detroit, Mich.
FOSTER, FRED J., Neosho, Mo.
HARE, F. E., Manchester, Iowa.
HART, M. D., Richmond, Va.
HAYFORD, CHAS. O., Hackettstown, N. J
JUDD, E. T., Cando, N. Dak.
KOPPLIN, PHIL., St. Louis, Mo.
KULLE, KARL C., Suffield, Conn.
LAVERY, PETER J., Bass Lake, Ind.
LEACH, GLEN C., Washington, D. C.
MANNFELD GEO. N., Indianapolis, Ind.
MILES, LEE, Little Rock, Ark.
MOLLAN, W. K., Bridgeport, Conn.
MOORE, DR. EMMELINE, Albany, N. Y.
NOBLE, P. S., St. Louis, Mo.
O'BRIEN, W. J., Gretna, Neb.
OSBURN, R. C., Columbus, Ohio.
POPE, T. E. B., Milwaukee, Wis.
PORTER, RICHARD, Paris, Mo.
RILEY, MARK, San Morcos, Texas.
SEABURG, ERNEST, Seattle, Wash.
TAYLOR, HERBERT, St. Louis, Mo.
TITCOMB, JOHN W., Hartford, Conn.
TULIAN, E. A., New Orleans, La.
WEBSTER, B. O., Madison, Wis.
WIEMEYER, WM. J., St. Louis, Mo.
WOODS, JOHN P., St. Louis, Mo.
YOUNG, E. C., Ottawa, Canada.
YOUNG, FLOYD S., Chicago, Ill.

REPORT OF THE EXECUTIVE SECRETARY

Washington, D. C.
September 12, 1923.

TO THE OFFICERS AND MEMBERS OF THE AMERICAN FISHERIES SOCIETY:

On account of my absence from the United States on an extensive official trip during the past year, the work of completing copy for the 1922 volume of Transactions of the Society was somewhat delayed. The lowest bidder for printing the volume was Griffith Bros. & Company, a smaller concern, and as it was later found, not so well equipped as the larger plants, which considerably delayed publication. The volume comprised 257 pages, containing 18 special papers and discussions in addition to the business proceedings of the Madison meeting. The total cost of printing the edition of 750 copies, with envelopes for mailing, was $1,078.84.

Upon submission of the bill to the Treasurer it was found that there were not sufficient funds to pay it and a partial payment of $600.00 was made, with the arrangement that additional payments would occur as rapidly as possible. This situation was due to the fact that a large

number of members (144) were in arrears for dues. The Treasurer furnished a list of these members and letters were at once sent out over the signature of the President stating the situation and asking for prompt settlement. As a result about 25 members have paid, leaving more than 100 yet to be heard from. Delivery of Transactions was withheld from 17 members who were in arrears for three years or more and their attention called to it in special letters. The names of such members are dropped if payment is not made promptly.

The Treasurer's report will comment more in detail in regard to the financial situation of the Society. I wish to go on record, however, as of the opinion that while at present we are about $2,000 behind, considering about $1,400 which remains to be replaced in the Permanent Fund, the Society is solvent. But the situation is serious if members do not pay their dues. This is our only source of revenue other than the comparatively small sum derived each year from the sale of Transactions. I strongly urge that every member pay his dues promptly. This will enable the Society to get on its feet financially and meet all future obligations.

Dr. H. M. Smith was appointed by President Leach to represent the American Fisheries Society at the exercises commemorating the 100th anniversary of the birth of Spencer Fullerton Baird, celebrated on February 3, 1923. Professor Baird, who was a noted man of the highest scientific attainments, was the creator and first head of the United States Fish Commission, and a prime mover in the establishment of the systematic study and development of the fishery resources of this country.

After careful consideration by the President and other members, it was decided that the financial status of the Society would not permit the offering of any prizes for papers contributed this year. In fact it seemed to be the opinion that prizes should not be again offered until all debts of the Society were paid off and the Permanent Fund fully restored, all income from that fund in the meantime to be applied to the reduction of the debt. Thereafter the Society should adopt the policy of not offering annual prizes which amount to more than the total income from the Permanent Fund in any one year.

Under date of July 30, the President issued a circular letter of information in regard to plans for the St. Louis meeting and urging attendance of all members possible.

Since the last meeting 11 members have died and there have been a few resignations. A number have also been dropped for non-payment of dues and other reasons. The present membership of the Society is as follows: Honorary, 63; corresponding, 12; patrons, 53; active, 576; total 704.

Respectfully submitted,

WARD T. BOWER,
Executive Secretary.

REPORT OF THE TREASURER

In the absence of Mr. Millett, the Treasurer, his report was read by Mr. Bower.

Boston, Mass., September 12th, 1923.

TO THE AMERICAN FISHERIES SOCIETY:

Herewith is submitted the annual report of the Treasurer from the meeting in Madison, Wisconsin, in September, 1922, to August 14, 1923. The financial showing of the Society for the past year cannot be called satisfactory. Despite frequent appeals of the Treasurer for the payment of dues and a personal appeal of the President to delinquents, there still remain unpaid dues. On the other hand, those in arrears for two years and over, number but 13. To these, special notices have been sent and the last number of the Transactions has been withheld from them. The Treasurer plans that if these dues are not paid by the time of this annual session the usual form of one month's notice will be sent to them, and then those who fail to respond will be dropped unless this meeting shall decide otherwise.

As for those in arrears for one year, it is but fair to presume that the large majority of them will pay within a reasonable time.

If the Society is to continue existence as an active force in its chosen field, it must immediately inaugurate some plan whereby the present indebtedness may be cleared up and also make provision that the annual expenditures shall not exceed the annual receipts.

For that reason, I would suggest the following:

First: A campaign to at least double the present active dues-paying membership of the Society.

Second: Active steps to secure, by pledges or otherwise, sufficient money to insure the annual payment of a stipulated sum annually into the Permanent Fund of the Society, this payment to continue until the indebtedness to the Permanent Fund is fully paid up with interest.

Third: A closer understanding and more effective cooperation between the officers of the Society.

Taking this opportunity to recall to the members that the authority of the Treasurer is limited to only the solicitation and collection of dues and the disbursing of monies for the payment of such properly approved bills as may be presented to him, I invite your attention to the following financial statements:

Balance on hand at the meeting of 1922			$203.42
Receipts			
For annual dues:			
Individuals, 1920	$6.00		
" 1921	62.00		
" 1922	1,000.00		
" 1923	17.00		
Clubs, 1922	130.00		
Companies, 1922	5.00		
States, 1922	100.00	$1,320.00	
Life Memberships		25.00	
Sale of Transactions		104.00	
Adjustments		3.20	1,452.20
			$1,655.62
Disbursements			
Reporting meeting of 1922		$250.00	
Letterheads. stationery, etc.		118.08	
Printing Transactions of 1922 (on account) (Total bill $1,078.84)		600.00	
750 books, 257 pp.	$854.11		
Changes and corrections	142.90		
Cuts	61.58		
750 envelopes printed	20.25		
	1,078.84		
Telegrams and postage		121.65	
Bower	62.19		
Barber	16.82		
Millett	42.64		
	121.65		
Services		459.71	
Haynes	50.00		
Rimbach	100.00		
Bower	300.00		
Multigraph	9.71		
	459.71		
Refunds		7.50	$1,556.94
Balance on hand			$98.68
Permanent Fund			
Balance on hand at meeting of 1922			$1,844.97
Disbursements			
Prize papers			200.00
Balance			$1,644.97

Memoranda

Outstanding bills:

Balance on bill Griffith Bros. & Co. 1319 F St. Northwest, Washington, D. C. Bill of July 26, 1923, for Transactions of 1922		$478.84
Total of bill	$1,078.84	
Paid on account	600.00	
Still owing	$478.84	
Due permanent fund, balance of amount borrowed Aug. 4, 1922 to pay for printing the Transactions of 1920		1,369.74
Borrowed	$1,991.15	
Paid on account	621.41	
Still owing	$1,369.74	
Ward T. Bower for years from meeting of 1922 to meeting of 1923		300.00
Total indebtedness of the Society		$2,148.58
Interest on money borrowed from Permanent Fund		

Respectfully submitted,

(*Signed*) A. L. MILLETT,
Treasurer

NOTE:

Since the books of the Society were closed on August 14th there has been received by the Treasurer $164. A portion of this was for the sale of Transactions, but the larger part is due to the personal appeal of the President to delinquent members to pay their dues. This effort of the President and Secretary also brought in several new members and increased the bank balance of the Society of $98.68 on August 14th to $262.68 on this date, Sept. 12th. For this reason there will be sent to Griffith & Co., printers of the Transactions, to whom a balance of $478.84 is owed, a check for $150, bringing the balance owed this concern to $328.84. This leaves the Society a present bank balance of $112.68, which I consider none too large to reserve for emergencies.

(*Signed*) A. L. MILLETT,
Treasurer

MR. TITCOMB: Certainly we should meet the cost of any assistance the Secretary has to have, but it seems to me that in view of our present financial position we ought to find somebody in this Society who is so situated that he will look upon the office of Secretary as an honor. That item of Secretary's salary, then, could be discontinued until a proper financial condition warrants an honorarium each year.

MR. WOODS: My suggestion would be the appointment of a special committee to deal with the whole question of the secretarial position, salary, and so on. This suggestion was made a motion, seconded and carried.

PRESIDENT LEACH: The next business will be the Reports of Vice-Presidents of Divisions.

Mr. Hayford presented the report of the Division of Fish Culture.

MR. HAYFORD: Sportsmen are no longer satisfied with anything less than trout 6 to 8 inches for stocking purposes. Fish culturists must know how to breed a strong vigor into trout, that the fish may not be susceptible to every hatchery disease.

MR. POOLE, Division of Commercial Fishing: The importance of the fish industry in most parts of the world is proven by the extent to which its welfare has entered into national politics. The industry is languishing. It sorely needs the assistance the Government can render. I recommend that every member of this Society get behind the Bureau of Fisheries program for the coming year. Give such assistance as you can through your Representatives in Congress on behalf of appropriations for Bureau activities.

The Vice-Presidents of the Divisions of Aquatic Biology and Physics, Angling, Protection and Legislation, did not submit reports.

A greeting was read from Mr. Henry O'Malley, United States Commissioner of Fisheries.

COMMITTEES.

PRESIDENT LEACH: I wish to announce the appointment of the following committees.

Committee on Nominations: Nathan R. Buller, Carlos Avery, E. A. Tulian, J. H. Brunson, C. F. Culler.

Committee on Time and Place of Meeting: John W. Titcomb, G. C. Embody, W. C. Adams.

Committee on Resolutions: Dr. R. C. Osburn, E. W. Cobb, Dudley Berwick.

Auditing Committee: T. E. B. Pope, Fred J. Foster, Chas. W. Burnham.

Special Committee re Financial Status: J. P. Woods, R. C. Osburn, J. W. Titcomb.

Special Committee on Pollution: N. R. Buller, Chairman. Other members of Committee to be selected by Mr. Buller.

PRESIDENT LEACH: We will now take up the reports of committees.

PROPOSED AFFILATION OF SHELLFISH COMMISSIONERS

MR. BOWER: Mr. President, perhaps at this time the question of the affiliation of the Association of Shellfish Commissioners with our Society may properly come up. Since the last meeting there has been considerable correspondence on the subject, with absolutely negative results.

MR. JOHN P. WOODS: Mr. Adams is better posted on this subject than anybody else, I suppose?

MR. BOWER: He had some correspondence on the subject with Mr. Marshall. In fact, I wrote Mr. Adams and sent him a copy of my communication to Mr. Marshall. It was not returned, so I assume that he received it.

MR. TITCOMB: I move that the matter be laid on the table until Mr. Adams arrives.

Motion was seconded and carried.

MR. BOWER: There are two or three minor matters of business to be disposed of. There is a request from the Deutscher Seefischerei-Verein, of Berlin, which desires to exchange publications with this Society and to be placed upon its records as corresponding member. I move that this organization be added to our list of corresponding members.

The motion was seconded by Mr. Titcomb and carried.

REPORT FROM CORRESPONDING MEMBER

A letter from David G. Stead, Fisheries Enquiry Commissioner of New South Wales, who is a member of the American Fisheries Society, was received by the Secretary. He recommended that all governments and countries bordering on the Pacific undertake not only ordinary research work in fisheries, but that they organize a system of fisheries research and exploration which will bring about results of national and international economic importance. He suggested that the 1924 meeting of the American Fisheries Society be an International Fisheries Congress to discuss the world's future in fisheries.

MR. BOWER: A communication has been received from the American Peace Award requesting that its literature be made available to the members of this Society at this meeting.

There has been an extended correspondence with the National Coast Anti-Pollution League, with headquarters at Trenton, and a request has been made that a resolution be passed by this organization, if possible, in connection with the work of that League. Mr. Buller is connected with the League, and I believe that he will have something to say in respect to the matter at a later stage.

One of the members of our Society, Mr. Nap. A. Comeau, of Godbout, province of Quebec, Canada, has written a book which should be interesting to members of the Society. It is entitled, *Life and Sport on the North Shore.* The book treats of hunting, fishing, shooting, trapping, natural history and Indian folk lore. It is a volume of 440 pages, containing thirty-six photo engravures, and may be obtained at a cost of $3.50 for cloth binding and $2.50 for paper, postage 20 cents extra.

I may announce that two or three additional papers have been received since the printing of the program. Mr. John N. Cobb, Director of the College of Fisheries, University of Washington, has sent a paper entitled, "The Future of the Fisheries of the Pacific," and Mr. E. A. Tulian has two brief papers, one on the subject of the "Shrimp Industry" and the other in regard to "Hatching."

Dr. Osburn presented his paper, "Natural and Artificial Conditions Affecting the Black Basses." Discussion followed.

Before a recess for luncheon there was a short discussion on the position of the executive secretary.

Second Session, Monday Afternoon, September 17th.

President Leach presided.

Discussion of Dr. Osburn's paper continued.

"The Sportsmen's League.—A Neglected and Undeveloped Power for Conservation," was presented by Mr. Fred J. Foster, U. S. Bureau of Fisheries, Neosho, Mo. Discussion followed.

"Museum Methods in Relation to Fisheries," was presented by Mr. T. E. B. Pope, Curator, Public Museum, Milwaukee. Discussion followed.

A paper entitled "Are We Maintaining the Whitefish Supply In Lake Erie?" by Mr. S. W. Downing of Put-In-Bay, was read. Discussion followed.

"The Future of the Fisheries of the Pacific Coast," by Professor John N. Cobb, was read by Mr. Bower.

The meeting adjourned until Tuesday, September 18, at 9.30 o'clock, a.m.

Third Session, Tuesday Morning, September 18th.

The meeting was called to order at 9.30 a.m. by President Leach.

MR. TITCOMB: I would make the motion that the papers of those who are here be presented in the order in which they appear on the program, those of the absentees being deferred until we have heard the others. In that way an opportunity for full discussion will be afforded.

The motion was seconded by Mr. John P. Woods and carried.

Applications for membership were read to the meeting by the Secretary and, on motion duly seconded and carried, the applicants were declared elected members of the Society.

Dr. Emmeline Moore, Albany, presented a paper on "A Report of Progress on the Study of Trout Diseases." Discussion followed.

Mr. Eben W. Cobb, of the Conservation Commission, Minnesota, read a paper on "Pike Perch Propagation in Northern Minnesota." Discussion followed.

Mr. Hare read his paper entitled, "Headwaters." Discussion followed.

PRESIDENT LEACH: Mr. Woods will present the Report of the Special Committee appointed to inquire into matters pertaining to the position of Secretary of the Society.

MR. JOHN P. WOODS: This committee recommends the temporary formation of an Editorial Board of four, comprising Dr. G. C. Embody, Managing Editor; Dr. Emmeline Moore, Dr. R. C. Osburn and Mr. John W. Titcomb; all of whom are to edit jointly the papers, and all of whom promise to do so with despatch.

I move that the report of the committee be adopted.

MR. POPE: I will second the motion.

The report was unanimously adopted.

The meeting took recess for luncheon.

Fourth Session, Tuesday Afternoon, September 18th.

The meeting resumed at 2.30 p.m., Dr. Embody occupied the Chair. Mr. Tulian presented a paper, "Present Status of Louisiana Shrimp Industry."

"Some Consideration Concerning the Canning of Sardines," was read by Harry R. Beard, San Pedro, California. Discussion followed.

Mr. C. A. Bullock presented a paper on "Some Problems in Bass Culture at Cold Springs, Georgia Station." Discussion followed.

A Symposium on Foods and Feeding of Fishes followed.

Fifth Session, Tuesday Evening, September 18th.

The meeting was called to order at 8.15 p.m. The President presided.

A paper on "Fish Distribution by the Federal Government" was read by Mr. E. C. Fearnow.

"Production of the Fresh Water Mussel" was presented by Mr. H. L. Canfield. Discussion followed.

Following the showing of slides and pictures, some of them illustrative of the papers read, the meeting adjourned.

Sixth Session, Wednesday Morning, September 19th.

The meeting was called to order at 9.30 a.m. the President in the Chair.

"Angling: Past, Present and Future," by Dr. James A. Henshall of Cincinnati, was read by Mr. Bower.

MR. AVERY: It seems to me that this paper ought not to be passed without extending our greetings to Dr. Henshall and the thanks of the Association for his most excellent presentation of this subject. If any of us are fortunate enough to reach the age of eighty-eight and possess the keen mentality of Dr. Henshall, it will be a matter of congratulation to himself. I move you, Mr. President, that we extend our greetings to Dr. Henshall on this occasion and that the Secretary be requested to wire him accordingly.

The motion was seconded and carried unanimously.

PRESIDENT LEACH: It is a very remarkable paper from a very remarkable man. Dr. Henshall is to be commended for the interest he has taken in fishing; he is recognized as an authority on these subjects throughout the United States and Europe.

"Notes on the Propagation and Distribution of Pond Fishes," prepared by G. W. N. Brown, was read by Mr. Canfield.

Discussion on *Pollution* followed.

"Planting Eyed Salmon and Trout Eggs" prepared by C. W. Harrison, was read by Mr. Foster. Discussion followed.

"Netting Coarse Fish vs. Black Bass" was presented by J. P. Snyder.

Under head of New Business there was a valuable discussion on Carp; Work of the International Association of Conservation Commissioners and Fearnow Transportation Pail.

Reports of Committees followed.

It was moved and seconded that time and place of next meeting be left to the Executive Committee of the Society.

The motion was carried.

The report of the Committee on Nominations was submitted. It was moved and seconded that the report be accepted. The motion was carried, and a ballot was cast for the officers.

President	GEO. C. EMBODY
Vice-President	EBEN W. COBB
Executive Secretary	JOHN W. TITCOMB
Recording Secretary	FLOYD S. YOUNG
Treasurer	T. E. B. POPE

Vice-Presidents of Divisions:

Fish Culture ..... C. F. CULLER
Aquatic Biology and Physics ..... DR. EMMELINE MOORE
Commercial Fishing ..... JOHN N. COBB
Angling ..... DUDLEY BERWICK
Protection and Legislation ..... W. E. ALBERT

Executive Committee:
Charles O. Hayford, Chairman; Max D. Hart, Edward E. Prince, Lee Miles, George Shiras, 3d., E. T. Judd.

Committee on Foreign Relations:
F. C. Walcott, Chairman; W. C. Adams, R. E. Follett, Ward T. Bower.

Committee on Relations with National and State Governments:
Nathan R. Buller, Chairman; E. T. D. Chambers, Carlos Avery, Henry O'Malley, W. E. Barber.

Special Pollution Committee: Nathan R. Buller, Chairman, to select other members.

Editorial Board:
Raymond C. Osburn, G. C. Embody, Dr. Emmeline Moore, John W. Titcomb.

The report of the Auditing Committee was submitted and on motion, duly seconded, was adopted.

Chairman of the Resolutions Committee, read the following resolutions:

ALASKAN SALMON FISHERIES

WHEREAS, The Congress of the United States has not adopted legislation for the administration of the fisheries of Alaska which will give the Secretary of Commerce authority adequate for the control and preservation of the salmon industry of Alaska, and

WHEREAS, To meet the existing emergency reservations have been created by the exercise of the power vested in the President under which the necessary restrictions on operations have been applied in the districts which include Cook Inlet, Kodiak and Afognak Islands, Bristol Bay, Alaska Peninsula, and the Aleutian Islands, and

WHEREAS, A similar situation exists in the central and southeastern districts of Alaska which threatens the continuance of the salmon fishery

Now therefore be it resolved, That it is the sense of the American Fisheries Society in convention assembled at St. Louis, September 17, 18, and 19, 1923, that we heartily endorse the policy inaugurated by the creation of these reserves and recommend that further action of this nature be taken by the creation of reservations which will include all of the fishing districts of Alaska not covered by the reservations already in existence.

POLLUTION

WHEREAS, The presence of oil from oil-burning steamships and of trade wastes from various industries in the navigable waters and in streams of this country is resulting in an increasing amount of damage to the fish, oyster and game bird food supplies of our nation, to the sea bathing, boating, fishing and hunting, recreational opportunities of our people, to the purity of our water supplies, and is a fire menace in many quarters and

WHEREAS, There has recently been formed the National Coast Anti-Pollution League, uniting in one program the various interests that wish to end pollution of the waters and having these objects:

"To foster and aid the enactment and enforcement of adequate remedies and legislation to prevent the pollution of navigable waters and to secure the co-operation of those responsible for such pollution in accomplishing its elimination by all lawful means."

Therefore, be it resolved, That we, the American Fisheries Society, in convention assembled, do hereby endorse the efforts of the National Coast Anti-Pollution League to end pollution of the coastal waters by oil, and

Further be it resolved, That the President of this Society is hereby authorized and requested to appoint a committee of three to co-operate in all matters relating to pollution of the waters with the National Coast Anti-Pollution League to lend their fullest support to its efforts, and to attend if possible the conference of that League in Atlantic City on October 1, 2 and 3.

DRAINAGE MISSISSIPPI BOTTOMS

WHEREAS, The maintenance of fish and other aquatic life is of great importance to the people of the country, and is essential to their welfare as a source of food supply and a means of recreation, and

WHEREAS, Suitable areas for the breeding and life of the fresh water fishes are constantly being encroached upon for the avowed purpose of commerce and agriculture by means of ill advised and unnecessary drainage, and

WHEREAS, Under present agricultural conditions large increase in agricultural products, owing to an apparent over production of such products in this country, is unnecessary and because many drainage projects are of doubtful value as aids to agriculture, therefore

Be it resolved, That the American Fisheries Society is firmly opposed to the pending projects for dyking and drainage of the upper Mississippi River bottom lands, including that enterprise known as the Winnesheik project is subversive of the best interests of the American people, inasmuch as the culmination of these projects would obliterate and destroy the greatest and most productive breeding grounds for warm fresh water fishes on the North American Continent.

Transactions

Be It Resolved, That this Society considers it extremely important that the proceedings of reports received and papers read at the meeting be printed and distributed to its members within the period of three months after the close of the meeting.

Artificial Lakes

Whereas, The creation of lakes by the construction of dams for developing hydro electric power, or for conserving surplus water during the spring, thereby preventing floods; said lakes open to the public at all times during the open season for hunting, fishing or trapping and boating; said lakes likewise furnishing some of our best egg collecting fields, thereby providing means of perpetuating and conserving fishing for future generations, therefore,

Be It Resolved, By the American Fisheries Society that it hereby favors such projects as being the means for conserving surplus waters, affording refuse for birds and fish and providing recreational pleasures for the American public.

Research Work—N. Y. State Conservation Commission

Whereas, The attention of the American Fisheries Society has been drawn to the very important work on fish diseases and parasites now being conducted by the N. Y. State Conservation Commission, and

Whereas, This Society recognizes that such work is fundamental to the future conduct and policy of fish culture, and

Whereas, The rapid growth of population and increase of travel are placing a special drain on fish life,

Therefore, Be It Resolved, That this Society commends especially this research work and expresses the hope that the State of New York through legislative enactment and financial assistance, when necessary, will continue to carry on this work which is recognized to be of great benefit to the entire community.

Isaak Walton League

Whereas, The activities of the Isaak Walton League of America, its purposes, ideals and policies have been brought so prominently before the public within the past few months, and

Whereas, The saving of the fish, game, forests and streams of the United States and Canada is imperative at this time, the conditions of wastefulness and indifference having become a crime, and their correction an emergency, and

Whereas, The rapid growth of the Isaak Walton League of America is almost phenomenal, spreading as the organization has to almost all the states of the Union, and

Whereas, The efforts of the Isaak Walton League of America are pledged to save and protect the fisheries that this Society is known to foster and many of its members are engaged in producing, therefore

Be It Resolved, That the American Fisheries Society endorse the work of the Isaak Walton League of America, and that it hereby pledges its support and co-operation insofar as it is able to do, believing that the Isaak Walton League of America will be a sustaining aid in the accomplishments of this Society.

CONDOLENCE

WHEREAS, The hand of death has removed a number of valued members from our midst during the past year,

Be It Resolved, That this Society hereby expresses its sincere sorrow at the loss of these devoted members, and that their names be printed on a special "In Memoriam" page of the Transactions.

ST. LOUIS CONVENTION BUREAU

Be It Resolved, That the American Fisheries Society expresses its cordial appreciation to the St. Louis Convention Bureau for the admirable arrangements provided for the meeting.

HOTEL STATLER

Be It Resolved, That the thanks of the American Fisheries Society are due to the Statler Hotel's management for its courtesies and service during our meeting.

Their adoption was moved, seconded, and carried.

PRESIDENT LEACH: In connection with the representation of this Society at the forthcoming meeting of the Anti-Pollution League at Atlantic City, I shall appoint Mr. Buller as Chairman of the Committee to represent us; he will select two others to accompany him.

Dr. Embody the President-elect, was conducted to the chair.

PRESIDENT EMBODY: If I were permitted to have any one policy in connection with the work of this Society, it would be to bring into closer relationship the so-called scientific man and the practical fish culturist. In a sense, I do not like using those terms "scientific man" and "practical fish culturist." The practical fish culturist must be scientific if he is to make progress in his work, and the scientific man must have experience just as the practical fish culturist must have it, if he is to attain the success that he desires. You are all working for the same end; if you work together, something will be accomplished; if you do not work together you cannot hope to get very far.

Is there any other business to come before the meeting?

MR. FOSTER: I would like to offer a motion that a copy of the resolution with regard to the drainage of the upper Mississippi River be forwarded to the President of the United States and to the Secretary of War.

RETIRING PRESIDENT LEACH: I will second that, with the provision also, I suggest, that a copy be sent to the President of the Isaak Walton League.

The motion was agreed to.

MR. FOLLETT: Is it the intention of the Game Commissioners to take up this question of the drainage of the upper Mississippi?

MR. ADAMS: Yes. I do not know of any project in the United States to-day that is of greater importance than the protecting of the breeding grounds on the upper Mississippi River. I personally have already written to President Coolidge about this matter, and I think that every man in this room ought to do the same thing. We ought to do everything in our power to uphold the Isaak Walton League in initiating this legislation.

MR. LAWYER: I may say that the War Department has approved of that project only from the engineering standpoint.

MR. CULLER: But without that approval the project could not go through.

MR. LAWYER: I am not so sure about that. I had that out at one time with some of the officials of the War Department, and my understanding was that they were simply asked to give their advice on the advisability of the question.

RETIRING PRESIDENT LEACH: I move that we adjourn.

MR. JOHN P. WOODS: Mr. President, before we adjourn I think we ought to express our deep appreciation of the efficient services rendered by Mr. Leach during the past year. I think it is appropriate that we should indicate our feeling in that respect by a rising vote.

The motion was seconded and carried by a rising vote.

The motion for adjournment was seconded and agreed to, whereupon the Fiifty-Third Annual Meeting of the American Fisheries Society adjourned sine die.

In Memoriam

NAP. A. COMEAU

H. A. GRAMMES

JAMES B. MARVIN, Jr.

M. G. MUNLY

JOHN WADDELL

PART II

PAPERS AND DISCUSSIONS

NATURAL AND ARTIFICIAL CONDITIONS DETRIMENTAL TO THE BLACK BASSES

By Raymond C. Osburn
Ohio State University, Columbus, Ohio.

The black basses are outstanding among the game fishes of the fresh waters of America. Whether, as many sportsmen maintain, they outrank all others in this respect, we need not discuss here. They have this advantage, at least, that they appeal to a much larger and more widely distributed population than any other game fishes, since the two species, the large mouthed and small mouthed, which we shall consider together for the sake of brevity, range from the Atlantic States to the Great Plains and from the Gulf States far into Canada and live in lakes, ponds, large rivers and smaller creeks. They are important in that they yield a large amount of food of excellent quality.

Time was,—and that not so very long ago,—when all the waters of suitable size in the eastern half of the United States were supplied with these fishes to the full extent of the balance of nature. Such is no longer the case, owing to the checks which man has placed on their reproduction and development, and these and other fish now find existence impossible in multitudes of streams and some lakes and ponds.

There has been much discussion of the possibilities of bass propagation, in fisheries associations and sportsmens' organizations, but still it appears to be worth while to discuss the various conditions which limit the production of bass, and to attempt to estimate their future and the chances of increasing their numbers,—a thing so near to the heart of the large number of American anglers.

Let us first consider the various factors which limit reproduction and growth. Any given body of water under a state of nature will produce only a certain number of adult bass, depending especially upon the food supply, natural enemies and conditions for reproduction. As a very great over supply of eggs and young are usually produced, we may assume that the maximum number of adult fishes possible under the living conditions are continually present in a state of nature. The question arises whether it is possible to improve upon nature and to produce a larger number than could exist under natural conditions. We know that this

can be done in a limited way, because it is being done every year in our state and government hatcheries, but whether in the open waters, under more natural conditions, we can, to paraphrase an old saying, make two fishes grow where one grew before, is quite another matter. To do this would require certain changes in the natural conditions, especially the increase of the food supply and the removal of natural checks on reproduction and growth.

NATURAL CHECKS

The natural inimical factors which tend to limit the supply of adult basses in any stream or lake are; first, conditions interfering with spawning; second, parasitism and diseases; third, natural enemies; fourth, amount of food.

Bass are rather sensitive to environmental conditions at the spawning season, perhaps more so than any other fish. The sudden lowering of the temperature even a few degrees, just at the spawning season may interfere with the process of egg laying and cause the female to become egg-bound so that she may die as a result. Cases of this sort are common. Such temperature changes also cause the male to desert the nest, so that any eggs already deposited are lost,—as every hatchery superintendent knows to his sorrow.

Preceding such sudden drops in the temperature we often find spring storms occurring and these at times are sufficient to nearly or completely destroy the nests by washing them out or covering them with gravel, mud or other debris. I have personally known all the bass nests of a whole stream to be swept out by a succession of such storms during the reproduction season, so that no hatch was observable, even though numerous adults were present and nest making had been in active progress before the storms.

In Lake Erie I have observed similar conditions around the Bass Islands where I have studied the reproduction of the small-mouthed bass for the last five years. In 1919, when the weather was especially favorable during the breeding season, there was an astonishing hatch. One could not draw a small minnow seine (we used a fifteen foot common minnow seine in our studies) anywhere about the Islands without taking large numbers of young bass. The season of 1920 showed just the reverse. Heavy storms, with sudden drops in the temperature at inopportune times, apparently destroyed all the nests of the bass about the islands, with the exception of a few in well protected localities where the force of the storm could not reach. In 1921 this condition was repeated and no young bass were to be found

in any exposed situation. In 1922 conditions were much improved and young bass were to be found on all but the more exposed coasts. In the present year (1923) the condition of 1919 was again repeated; the season was rather late, the water was slow in arriving at the breeding temperature and when the season did open it came without storms or sudden temperature changes. The result again was an enormous hatch of the young bass on all the coasts around the Bass Islands and the other islands in their vicinity.

In smaller lakes and ponds storms do not play such havoc as the waves do not reach such a depth as to wash out or silt in the nests. The large mouthed bass is less affected by such untoward conditions than the small-mouthed bass for the reason that it is essentially a fish of the smaller lakes and quieter waters. During the same five seasons which I have just described as affecting materially the reproduction of the small-mouthed bass, the large-mouthed bass in the enclosed harbors of Catawba Island only a few miles away were not interfered with in their breeding operations and the production of young was constant as far as could be determined. The same was true in the smaller lakes of Ohio as observed especially in the Portage lakes near Akron and Buckeye Lake near the center of the state. The season (1923) was not as favorable for the large-mouthed bass as the four preceding years, because the shallower waters of smaller lakes did warm up to the breeding temperature and then drop again, causing many male bass to desert the nests and many females to become egg-bound.

It is doubtful just how much parasitism and disease check the production of adult bass, for the reason that it is very difficult to estimate the losses produced in this way and they are extremely variable. The black basses are apparently not often subject to epidemic diseases such as sometimes play havoc with trout and other fishes. However, they are occasionally found dead with the gills partially sloughed away and probably an appreciable number of them die from bacterial diseases, especially those affecting the gills. Parasites, on the other hand are quite numerous and it is rare to take a bass at any time of its life when it does not harbor some of these unwelcome guests. In adult bass they often occur in such numbers as to definitely injure the host. Parasites in the skin or flesh, "grubs" as they are usually called by the layman, may be present in such numbers that the fish are thin and gaunt and the flesh unfit for human consumption. Tapeworms also occur sometimes in such numbers that the intestine is practically obstructed by them. Larval tapeworms and other flatworms are also

found encysted in the liver and other internal organs in large numbers and no doubt interfere with the functioning of the organs containing them. Round worms, and especially the *Acanthocephala,* or thorn-headed worms, occur in the intestine where they attack the lining membrane. Leeches, crustacean parasites and some others may attack the skin and subject the fish to infection by the deadly fish fungus (*Saprolegnia.*)

Parasites produce the deadliest effects in the young fish. Certain protozoan parasites, unicellular, miscroscopic organisms, attack the skin of the young bass,even before they have left the nest. While these do not remain long to affect the fish, usually being gone before the young reach an inch in length, they may cause the death of many of the young fry by forming pustules in the skin which break to the outside. These were abundant on young small-mouthed bass about Put-in-Bay in June and caused considerable loss.

Internal parasites begin to affect the young bass as soon as they begin to feed. The first of these to make their appearance are young tape worms and fluke worms which have their larval stages in the minute crustacea (water fleas) which form the first natural food of the bass and most other fishes. The presence of large numbers of the early stages of these parasites at a time when the bass fry were still feeding entirely on these minute crustacea, called the attention of the writer to the fact that the parasites must inhabit these crustacea as their intermediate host. A former graduate student, Dr. R. V. Bangham, took up the problem and traced various species of tapeworms and fluke worms back to the species of crustacea which carry them. It is no uncommon thing for a young bass less than an inch long to harbor a score or more of these parasites and occasionally the number is much greater than this. They sometimes grow to maturity in the intestine of the bass, or they may penetrate the wall of the intestine and encyst themselves in the liver, spleen or other internal organs. Sometimes the liver is so full of these young parasites that it appears to have been riddled by them and there seems no doubt that they may cause the death of the fish. More frequently, it is probable they merely delay the development of the fry and weaken them so that they readily fall victims to the voracity of larger fish. Dr. Bangham has shown that heavily parasitized fish are smaller than others belonging apparently to the same hatch, so the effect is not mere supposition.

By the time the fry are an inch and a half long they have also accumulated some of the round worms, especially the

thorn-headed worms, which they obtain from larger crustacean food. (Wickliff, Transactions, Vol. L. p. 364-371 and Turner and Kraatz Transactions, Vol. L. p. 372-380, have shown how the type of the food varies in relation to the size of the fish.)

But it is not only the young fish that are affected by these enemies. The adults may sometimes be heavily infested with tape worms so that the intestine may be almost closed by them. Fluke worms may attack the liver and the coeca, especially, to injure the fish and thorn-headed worms may occur sometimes by the hundreds in the intestine and the coeca. Fishes so parasitized usually show it by the gaunt appearance, the absence of intestinal fat, the smaller size of the reproductive organs, etc. It is not possible to estimate with any degree of exactness the check which these parasites produce on growth and reproduction and it probably varies greatly in different waters and in different seasons, but it is undoubtedly important. It may not be possible to control parasitism in natural waters, but I shall have something to say later concerning the control of parasitism in hatcheries. Parasitic crustacea and certain of the fluke worms occur on the gills, but I have not found these numerous enough on the basses to produce serious results.

The natural enemies preying on the basses are many, especially in their younger stages. The predaceous water insects get some of them when they are very young. Predaceous fishes take their toll and it is not a small one. I have found young bass in the stomach contents of many fishes but especially in the yellow perch, the gars and the grass pike. To a lesser extent I have found them in catfishes of various species, the chubs, the crappies, the green sunfish and occasional others, while the larger bass do not hesitate to make a meal of their younger kin at times.

Frogs, snakes and turtles occasionally get the bass as a part of their diet, though the bass is usually too quick for such enemies. Various kinds of birds also take their toll of the young bass, as is well known. The common tern is protected and there has been considerable discussion pro and con as to the destructiveness of this bird on the game fishes. This much has come under my own observation. The small, barren Starve Island, near Put-in-Bay, Ohio, is inhabited by large numbers of terns which breed there. I have been unable to find any young bass about this island in several seasons, though the character of the bottom is suitable for breeding purposes. Careful investigation of the food of these birds may force us to include them among the undesirables.

FOOD

A factor which has not had sufficient consideration in fish propagation under natural conditions is the amount of food. Even men old in fisheries work sometimes appear to overlook the fact that fish cannot live on pure water alone, any more than land animals can live on fresh air. We have probably seen waters stocked with many more fish than could possibly find sustenance there. Furthermore, it is not only the amount of water, at its lowest stage, that is concerned, for the food crop of a lake or stream depends upon as many different factors as a crop on land and the chemicals in solution, the amount and kind of organic matter, the temperature, the amount of light, the character of the bottom and various other factors affect the productivity of any body of water. In the end this goes back to the production of aquatic plant life, for, just as upon land, the amount and character of animal life is conditioned by the plant life that furnishes the primary food source. Clear water will grow more food than muddy water on account of the amount of light which penetrates. Warm water will produce more than cold. A stream or lake that maintains a fairly constant level will produce more than the one which fluctuates greatly. To judge the productivity of a body of water, therefore, it should be studied at its worst and all the unsatisfactory conditions known. Many streams and some lakes become so low in dry seasons that they cannot support a fish fauna commensurate with their size at other seasons. Streams which are muddy for a considerable portion of the year cannot support as many game fish, nor as much life in general, as waters that are clearer. This is one of the reasons why lakes are more generally productive than streams, for they are seldom roiled to any extent.

The natural limit of fish production is therefore not conditioned by the reproductive capacity of the fish, which always produce an overplus of young if not interfered with, but upon the various factors which check the development.

ARTIFICIAL CHECKS

These are in the nature of the unsatisfactory conditions which the industry, the carelessness and the short-sightedness of man have thrown in the way of the natural balance of aquatic life. It is a sad commentary on human behavior that very few of our waters produce any where near as many fish as they did in a state of nature. "Increased production" has been the slogan of the farmer, the manufac-

turer, the miner and many other producers, while at the same time they have worked great detriment and often made impossible the productivity of the water in the vicinity of their operations.

The important human checks on the productivity of our waters are (1) pollution, (2) interference with the water supply and (3) over-fishing; these three, and the greatest of these is pollution. I shall not need to consider the pollution question at this time, for it has been discussed already and we are all of one mind that it has wrought more damage to our waters than all other things combined. The voters of the country have the solution of this matter in their own hands, but until they awake to the fact that there are more important things in the world than to find the easiest way to dispose of refuse and waste by dumping them into the water, the menace will continue to grow. The individual in the city is compelled to install plumbing and take other measures to care for household wastes and it is just as logical to expect the manufacturer, miner, canner, etc., etc., to care for his industrial wastes. It may make the products of industry cost more to the consumer and it may reduce the income of the producer somewhat, but there are some natural rights of all the people valuable beyond price and pure water is one of these. Pollution is the one absolute check on fish production, though fish production is only one of the questions involved in the pollution problem.

Interference with the water supply is another important menace to fish production, and this again is charged to the score of human industry. Deforestation is perhaps the most important phase of this problem. It is a common experience, observable everywhere in the more populous sections of our country, that the streams and lakes no longer maintain their original levels throughout the year. At the same time floods are higher and more destructive with the passing of the years, since there no longer exists the natural means of holding back the rainfall until it sinks into the soil. Streams that only a generation or so ago were good fish streams now become so low in dry seasons that game and food fish cannot live in them at all or only in more limited numbers, for the productivity of any body of water is measured not by the condition at its best, but at its worst and it will produce only such forms as will find cover and sustenance at its lowest stage. Reforestation of the hill tops and steep slopes will aid in stream recovery and the reduction of floods, and should be a part of every fish conservation program.

The cleaning up of stream and river bottoms is another factor in this problem. The brush and fallen tree trunks

that used to hold back the water at flood time have been removed in many parts of the country. In some places the stream beds have been straightened and dredged out and apparently everything done to hasten the escape of the water in as short a time as possible, and where this has been done the production of fish is usually made an impossibility.

Large areas of swamp land have been drained and this cuts off another source of constant water supply as well as a great source of food of the fishes. Many of the smaller lakes have been drained for agricultural purposes in the mistaken notion that a larger income can be obtained from the land than from the water. Much of this so-called reclamation work has proved to be utterly useless.

Another source of interference with water supply is that of drawing water from lakes for the manufacturing industries or for the purpose of making trifling improvements at the water's edge. It it only necessary to lower the water a few feet in most of our lakes to force the young fish into the open water where they are without protection and without their supply of natural food. The manufacturing industries will, of course, take no heed of this matter and boards of public works, when made up of political appointees and changing every few years, are not likely to understand the importance of maintaining a constant water supply in the waters under their control.

It should be the self-imposed duty of every sportsmens association and of every department of fish and game to encourage reforestation and to insist on the constant maintenance of the water supply. If it becomes necessary to lower the water for any purpose of construction, this should be done only at the approach of colder weather, when the fish naturally seek the deeper water.

Over-fishing is a menace that has increased with enormous strides with the development of the automobile and the motor boat. These two useful contrivances have made it possible for a greatly increased proportion of the population to go fishing. The ease with which one may now reach fishing grounds is the chief cause of over-fishing. Many of our smaller streams and lakes are annually almost depleted of fish of breeding size. It is true that our state fisheries bureaus can stock these waters and so maintain them for the people interested. The modification of our game laws, by increasing the legal size of game fish, would do much to prevent over-fishing and to insure the constant production of young. One of my assistants, Mr. E. L. Wickliff, has measured the size and estimated the age at breeding (by

the scale method) of many of our Ohio game fishes and has discovered that it is possible for the large-mouth bass to reach the legal limit of 11 inches without having had opportunity to breed. The elimination of spring fishing would curb this to some extent or the raising of the legal size to 12 inches would accomplish the same purpose. In the lakes this is not so important a matter as it is in the streams, where there are fewer fish and less cover and where over-fishing is more likely to occur.

Over-fishing at any rate, is not so serious as the other checks already discussed, for at least somebody profits by the fish taken for food and by the recreation involved in their capture and it does not hinder restocking, while pollution and interference with the water supply present no such mitigating features and make restocking futile. If boards of fish and game were more careful to investigate the waters they restock and refuse to stock waters that are impure or are otherwise tampered with, they might at least arouse the fishing population to the point where they would insist on doing away with these menaces to fish production.

Before closing I wish to say just a few words about the checks on the artificial production of young bass in hatcheries. Here the conditions are made as satisfactory as possible and most of the checks above mentioned are eliminated. Pure water is insisted on as a matter of course, but I believe that it is possible to eliminate parasitism to a greater extent. Some preliminary studies which I have made on our hatcheries in Ohio, indicate that it is not good policy to take water for the hatchery from lakes or streams and that springs should be the only source from which water should be drawn. We have both types in Ohio and while the percentage of hatch is about equal, the investigation of the young bass indicates that parasitism is almost absent in the young fish from spring-fed hatcheries where the ponds have been kept clean, while in those fed by streams and lakes parasitism runs as high as it does among the wild fish. Also where ponds are in series and the lower ones receive their water supply from those above, I believe it is the best policy to winter breeders in the lowest ponds of the series and use the upper ponds for breeding and rearing purposes. The upper ponds may then be drained and cleaned over winter and will be found practically free from organisms carrying parasites when the young bass begin feeding. The cleaning of the hatching ponds is also good insurance against the water becoming stale from the decomposition of organic matter at the bottom, which sometimes results in the loss of

large numbers of fry when the temperature goes very high during protracted hot spells.

As to the future of bass production I wish merely to indicate some of the possibilities for I realize that prophesying is dangerous to the reputation. In judging of the possibilities it is necessary to consider whether the natural and artificial checks which now exist may be modified in either direction in the future.

1. As to conditions which interfere with spawning, it seems futile to attempt to devise any method of preventing storms or sudden deleterious changes in temperature. Pollution may be cleared up so the bass can return to their original spawning grounds and thus extend their area of distribution.

2. Parasitism and disease are not likely to be controlled to any extent in wild fishes, except through the destruction of fish-eating birds and other animals which are the intermediate hosts of fish parasites, though it may be possible to prevent parasitism to a large extent in hatcheries, as is already stated.

3. Natural enemies can be controlled to a great extent and some of these are already much fewer than in a state of nature. Fish-eating birds and reptiles are less numerous than formerly and likely to become still more reduced. Highly predaceous fishes, such as the pikes and gars, which prey on the basses, have been reduced to some extent. The pikes are good game fishes and are edible, but the worthless gars are usually more numerous. Every sportsman kills them when opportunity offers, of course, and in some lakes they have been netted to advantage to get rid of them. It would seem possible to reduce the number of enemies very considerably. It may be argued that the bass are vicious enemies of their own young and this is sometimes the case, but every young bass that enters the stomach of an older one at least contributes to the supply of larger bass, so there is an element of consolation in this. Moreover if there is plenty of cover and food the young bass are not likely to be greatly depleted by attacks of the larger ones.

4. The amount of food is naturally a very vital question. The cleaning up of swamps and stream beds and the bottoms and shores of lakes reduces the amount of natural food as well as cover. Deforestation, resulting in alternate floods and seasons of extremely low water, has the same result. The lowering of the water level in smaller lakes and reservoirs for water power or for construction work has a very deleterious effect on the food organisms as well as on the young fish directly. The cultivation of farm lands results

in the carrying into the streams a larger amount of silt and the muddying of the waters to a greater extent than obtains in nature and this is harmful to the food supply as well as to spawning beds. The seining of minnows and other small fish for live bait is a menace to bass production since it deprives them at once of a large amount of natural food. In many smaller streams and on the shores of lakes this has gone to the extent that anglers are complaining that they can no longer get live bait. It is well known that large numbers of the small fish taken for live bait die before they are used and are thrown away. Time is about ripe for a campaign against this useless waste of good bass food, for when anglers are unable to obtain minnows for bait with a seine the question arises; what are the bass finding for food to replace them? I am of the opinion that it would be well to restrict the seining of small fish for live bait.

Reforestation will aid in reestablishing the water level of streams and education will have some effect in preventing over-cleanliness such as the removal of vegetation from shallow water, etc., and in preventing the lowering of the water level in lakes at seasons when fish and their food are most susceptible to the change. It is even possible to fertilize a body of water to make it more productive of lower organisms, to plant with aquatic vegetation suitable for cover and to introduce smaller fishes which will serve as food for the basses.

5. Over-fishing can be controlled by limiting still farther the size of the fish legally taken and by preventing spring fishing before the adults have had an opportunity to breed at least once. Restocking from hatcheries is a satisfactory method, as far as it goes, and my observations indicate that often the fry may be taken from lakes and streams without injury to the fishing in those waters, when the natural hatch is excessive. I feel sure that millions of young small mouthed bass might have been removed from Lake Erie about the Bass Islands the past season without doing any injury to the future fishing prospects and the same has been true of the large mouthed bass in many of our smaller lakes season after season as I have observed them, for not one out of a hundred young could possibly come to maturity and find food and range. Over-fishing is probably the least important of the checks to production except in restricted localities.

6. As to pollution, I look forward to the time when the American people will no more tolerate this than they do certain other public nuisances. Then the bass may be restored to their original haunts and the area of bass production in-

creased again to its original limits. It will be a hard fight, undoubtedly, but the people can have anything they want if they are only willing to go after it.

One interesting and encouraging feature of the present situation is the much larger number of people who are interested in fishing as a part of their recreation. To be sure many of these are now driving long distances for the purpose of trying their luck, instead of attempting to improve conditions at home, but they will be keen to improve their own waters when they see the way to do it. Sportsmen's organizations are rapidly becoming more numerous and powerful and these societies will have an excellent influence in educating the general public as to the ways and means of obtaining what they want. To restore our waters to their original cleanliess and productiveness should be our first organized effort.

Discussion.

PRESIDENT LEACH: The Bureau of Fisheries has been depending on Lake Erie for a certain amount of brood stock each year which it has transported to its nearby fisheries stations. We have noted that we have transferred also some of the parasites of which Dr. Osburn speaks; some, I believe, have been sent to Neosho for Mr. Foster to contend with.

I notice what Dr. Osburn says about Starve Island, the area of which, I believe, is not more than about one half an acre. May I ask Dr. Osburn whether he attributes the scarcity of bass there to the terns?

DR. OSBURN: Bass of breeding size are caught in numbers there when the angling season is on, but in the course of five years, seining for investigational purposes, we have never found any young bass. I am not sure whether the terns are responsible. The matter needs careful investigation.

PRESIDENT LEACH: Have you found the same conditions regarding the bass around Hen and Chickens Island, which are very thickly inhabited by terns?

DR. OSBURN: I have not studied the conditions affecting the Big Chicken Island, where so many of the terns breed, though I have visited most of the others,—the Sister Islands, Green Island, Rattlesnake Island, etc., where the terns are not numerous and where the bass fry have been taken.

PRESIDENT LEACH: The Bureau has sent to its hatcheries, where they are used for the propagation of smaller fish, a great many adult fish taken from Lake Erie; and the State of Ohio, I understand, distributes a great many of these adult fish to interior waters. Do you think that if that practice is continued the result will be a depletion of the small-mouth bass?

DR. OSBURN: Of course, a great many bass are caught out each year by anglers and a good many are taken for the purposes you men-

tion, but that does not seem to have greatly affected the supply. As for the large-mouth, we get a great many of them also and distribute them to the quieter waters of the state. There are three large, well-protected harbors on Catawba Island, comprising thousands of acres of water ranging in depth from a few inches to a few feet, and there the large-mouth hatch, in spite of the fact that many have been taken for stocking and by anglers, has been well kept up.

As to the distribution of parasites referred to by Mr. Leach, of course that is possible, provided that the parasite can find an intermediate host. It undergoes the larval stage in some small organism and comes to the adult stage in the bass. If the small organism which carries it in the larval stage does not occur in the waters stocked, the parasite could not complete its life history. Certain kinds of parasites might be transferred, others not.

MR. S. W. DOWNING: May I ask whether the taking of fish from the vicinity of the islands and their distribution in the inland waters of the state during the past eighteen years has increased the supply of small-mouth bass in those waters?

DR. OSBURN: I doubt if it has, but it has afforded a considerable amount of angling in the waters down state, and that is where the benefit has resulted. Whether or not the fish would have been caught had they remained in Lake Erie is another matter. The fishing about the Islands is not always as good as one might desire. I know from personal experience, though at times fish may be caught in considerable numbers. Apparently, however, plenty of breeding bass remain in Lake Erie; we had a good production of young bass this season when the conditions were favorable to breeding. The adult bass may lay from ten to twenty thousand eggs, and if a fair number of these hatch, you get a very rapid re-stocking.

MR. BURNHAM: How many years has the law been in effect prohibiting the sale of adult small-mouth bass in Ohio?

DR. OSBURN: I cannot answer that. It was in effect when I came back to the state six years ago.

MR. BURNHAM: It occurred to me that the number of adult fish saved by prohibiting their sale might offset the numbers that are being taken away for the purpose of stocking other waters.

MR. DOWNING: If the stocking of these streams has resulted only in providing a few day's fishing for the anglers, who take the breeders out after they are put in there, would it not be a whole lot cheaper to the state to furnish these anglers with a few messes of fish and leave the bass in the lake?

DR. OSBURN: But they get all the sport of catching them. In some places the fish may be caught out before they have an opportunity to breed, but we have a good many preserves in the state now where no angling is permitted until after breeding, and that has helped to keep up the supply of breeders. Where the taking of fish of legal size later in the season involves the removal of practically all the breeders from a stream or a considerable reduction of their numbers in lakes, the

introduction of more breeders does tend to continue our supply of fish in a way that would not, I think be possible otherwise under our present angling laws.

MR. HAYFORD: For a number of years we have been doing some of this work in connection with certain of our reservoirs in New Jersey. I find that if the adults are moved in the fall of the year we generally have splendid results in the reproduction the following spring. In the case of those that were handled about ten days before spawning, very few of them ever spawned; and on opening them up we found the eggs decomposed. If the big bass are left in the municipal reservoirs and the yearling bass taken, those which are from five to seven inches long, some results can be obtained, but as for removing the big bass, it is simply cutting off the fountain head of supply.

MR. BULLER: I am very much interested in what Professor Osburn has said in his paper with regard to the amount of fish in certain waters depending largely upon the amount of food available in those waters. In Pennsylvania the practice of seining for minnows, on the part of fishermen and those dealing in bait fish, was practically destroying the minnow life in our streams and inland lakes. It has therefore become necessary for us, in addition to propagating fish for the stocking of waters, to propagate minnows and introduce them into those streams for food, at the same time prohibiting seining for minnows. We have a law on the statutes today which imposes a penalty of $100 upon anyone who seines in the waters of Pennsylvania at any time of the year, with the exception of the waters below McCall's Ferry dam and in the Delaware river, as well as within the limits of the tidal waters. The seines are permitted there for the catching of shad. That law was enacted for the sole purpose of protecting the food which is absolutely necessary to fish life in those streams.

DR. OSBURN: Can live bait be used in Pennsylvania?

MR. BULLER: Yes. We do permit the use of a small dip net not to to exceed four feet in diameter, but there must be no seining. Since the enactment of that law, and with the propagation and distribution of minnows, the food is increasing, and, from the reports received from the bass fishermen, bass fishing is improving in spite of the many disadvantages that we have to contend with. The increase in bass fishing in Pennsylvania is due, in my opinion, not so much to artificial propagation and the stocking of waters as to the law that we have relative to the taking of bass. The close season is up to the first of July, thereby giving the adult bass a chance to reproduce.

DR. OSBURN: There is no Spring fishing?

MR. BULLER: No. These are two things that are helping bass fishing in Pennsylvania. As to the removal of adult fish, we do some of that work, and having the close season up to the first of July we are reasonably sure that they have reproduced before the fishermen take them.

With Pennsylvania—and I think every state has found itself in the same position—the difficulty of getting sufficient funds out of the

general revenues to carry on the work of the Department of Fisheries had been getting more acute each year. About twelve years ago the matter of requiring resident and non-resident fishing licenses was first taken up. At each session of the Legislature for ten years I fought to get some enactment of that kind on the statutes, and in 1922 it went into effect, not in the shape in which it was introduced into the House and the Senate, but in the form of a compromise. The original bill as introduced by the Department placed the minimum age limit at sixteen years; the bill we got through made the minimum age limit twenty-one years. After consulting the Governor on the question, who helped in every way to enact this law, we came to the conclusion that we had better take half a loaf than no loaf at all, and depend on future legislation to remedy any deficiency. In the first year that this law went in to effect, 1922, the Department sold 203,000 resident fishermen's licenses. We had our officers make a careful study as to the fishermen who were fishing the streams, and we found that two-thirds of them were under twenty-one years of age. In 1923, out of the turmoil we had in the House and the Senate, we succeeded in having the maximum age established at eighteen years, and the result is that we have sold this year up to date resident licenses in the amount of $335,000.

MR. JOHN P. WOODS: At what price?

MR. BULLER: One dollar. We think that at the next session of the Legislature, with the educational campaign that we are carrying on among the fishermen, we shall be able to get the bill back to its original shape, and we feel satisfied that we shall then sell every year 600,000 fishermen's licenses. There are 600,000 hunter's licenses sold in the state to-day, and we feel, from the knowledge we have, that we have as many fishermen as hunters. The men who are contributing this money are entitled to take a few bass or other fish out of the streams before they have had the chance to breed. They are the men we are depending on today for funds, and they are the men upon whom, in my judgment, every state in the Union will have to depend if we are successfully to carry on our work.

MR. TITCOMB: I was very much interested in Dr. Osburn's paper; it covers a very large field. I would like to ask him to what extent he examined the bass which he found egg-bound?

DR. OSBURN: That has been chiefly the work of one of my assistants, an instructor in the university, Mr. E. L. Wickliff. He has examined a great many of them, at Buckeye Lake especially. I had some bass sent in to me by the Department of Fish and Game this spring which were otherwise in perfect condition, but the eggs were degenerated and a mass of mucous had formed a kind of block in the end of the oviduct.

MR. TITCOMB: When they become egg-bound they subsequently die?

DR. OSBURN: Some of them undoubtedly die in that condition but it is an open question what percentage of death is from that cause We had this same experience in the New York Aquarium with fishes that could not spawn because conditions were abnormal.

MR. TITCOMB: That applies to other species as well?

DR. OSBURN: Yes, many of the marine species. Almost always the females would die off first. For instance, we kept striped bass until some were more than twenty years old, and all we had left at the end were a number of old males.

MR. TITCOMB: With regard to parasites, you referred to the desirability of using spring water and keeping the adults in the lower ponds; you would move these adults to the upper ponds for breeding purposes?

DR. OSBURN: Yes.

MR. TITCOMB: Do they carry the parasites with them?

DR. OSBURN: If they do, they would not in most cases distribute them that year to the young fish. Some of these parasites have to be carried over the year before they can reinfect the fish. That is to say, the fish will carry the parasite through the summer season, the parasite sometimes reaching the adult condition in a couple of months or so; then they will produce their eggs, which pass out into the lower organisms and there be carried over the winter. It is just a question, then, of breaking up the life history of the parasite; if we can do that at any point we have got him.

MR. TITCOMB: Do you think we could keep the ponds that are spring fed free from parasites for any definite period?

DR. OSBURN: I think you could. Some of these lower organisms can hibernate in the mud, or can encyst themselves and get through the winter in that way, but a sudden draining off of the water would have the effect of seriously interfering with this procedure. The result would be that the next year you would start in free from that kind of organism carrying parasites.

MR. TITCOMB: We have in Connecticut one small-mouth bass breeding establishment that I am familiar with. There the water is supplied to concrete pools used for breeding the dimensions of which are, I should judge, about 10 feet by 30 feet. The bass are taken from the private lake in the spring and reproduced in these lower pools; then the fry are taken from the nests and put into these concrete pools. The superintendent keeps two crews of men at work on the lake above which is the source of water supply, two small power boats being engaged in dragging for plankton. He feeds the little bass in the concrete pools on plankton until they are about an inch and a half long. Some years he has a very good production, and some years he loses 100,000 in a night from what he has called fungus. I happened to be there at the time this sudden mortality occurred; he thought it was brought about by something in the plankton. What would be your theory about that?

DR. OSBURN: I do not think there is anything in the plankton that could ordinarily bring about that sort of loss.

MR. TITCOMB: In that netting he would probably get the parasites too, would he not?

DR. OSBURN: Undoubtedly he would get the organism carring the parasites if he took them by netting the plankton, and the young fish would then carry probably as many parasites as the fish in the lakes where he got the plankton.

MR. TITCOMB: I understand that you have been netting the lakes in your state for adults to move to the inland waters? Do I understand from your remarks that the fishing in the lakes has kept up under those conditions?

DR. OSBURN: As far as I know there has been no depletion of it within five or six years.

MR. TITCOMB: That would mean that there is plenty of food to enable the young fish to go on naturally and take the place of those which are removed?

DR. OSBURN: Certainly, and there are plenty of breeders left. There are enormous hatches right in the waters where many breeders have been removed annually for inland use.

MR. TITCOMB: And all these parasites and other enemies of the fish which you recounted in your paper are the natural enemies you may expect in any water to take care of the surplus reproduction? It is simply the normal condition?

DR. OSBURN: Certainly, under natural conditions there could not be more than a certain number of bass growing in Lake Erie or any other body of water, limited, as they are, by these natural checks on reproduction and growth. The question is, whether we are maintaining that number.

MR. TITCOMB: Do you not think that in any lake inhabited by bass if they can be protected through the spring until the spawning season is over, and if limits can be enforced as to the size which may be taken so that they may not be taken until mature, the natural reproduction in such waters will be all that that lake can possibly take care of? In other words, artificial propagation is not really necessary under those conditions?

DR. OSBURN: I agree with you. We have made a mistake, I believe, in many parts of the country in trying to increase the number of fish, especially of large-mouth bass, by planting in lakes where they already exist. I know that in some lakes where the bass have been planted from time to time there is a production of young that is far beyond the capacity of the lake to support when they become adults.

MR. TITCOMB: Have you ever observed whether the female spawn on more than one nest? Mr. Beaman, of Waramang Hatchery, who has closely observed the bass in those small breeding ponds and has at times tagged many of them, maintains that none of the females expel all their eggs at one time; that after depositing a certain number of eggs they leave the nest, and, a few days later either on the same nest or another one deposit more eggs, and that sometimes this process goes to the third time before all the eggs have been expelled.

DR. OSBURN: There is no doubt that the female does spawn several times; the eggs do not all mature at once, as they do in some fishes, and can not all be spawned ot one time. I see no reason why they should not go to any nest that was convenient.

MR. TITCOMB: Do you find the large-mouth bass much more predacious or destructive of other fishes than the small-mouth?

DR. OSBURN: I have no exact data on that, but judging from stomach contents, I would hardly say so.

MR. TITCOMB: Every time I have occasion to talk to a bunch of sportsmen in Connecticut, they say that the large-mouth bass is very destructive of other fishes; they attribute entirely to the large-mouth the disappearance of bullheads from waters in which they had formerly been very abundant. From what we have observed it is evident that the bullheads decrease after the bass are introduced, and, in one instance where the bass have been twelve years in quite a large body of water, the bullheads have practically disappeared. I believe the majority of the fishermen in Connecticut to-day are of the opinion that we would be much better off if we did not have the large-mouth bass in the state at all.

DR. OSBURN: They are both, of course, feeders on bullheads to a certain extent. The large-mouth bass lives in the quiet waters where the bullheads are most frequently found, while the small-mouth prefer the colder water and so do not come so largely in contact with bullheads. That may, in part, be the answer. I have no evidence on the question whether one is more predacious on the bullheads than the other, when they can get at them.

MR. TITCOMB: We have an interesting situation in Connecticut, which I think I mentioned at the last meeting. In that state it is unlawful to fish in the municipal reservoirs because of the danger of contamination, and we have concessions from the water companies all over the state under which we remove from these reservoirs all the adult fish that we can catch in large numbers by the use of trap nets. This is along the line of the work Mr. Buller is doing and along the line also of the work in Ohio. Last spring we took out something like 30,000 adult fish, including bass; in some instances we took small-mouth bass up to six or seven pounds. In keeping these fish where they will have a chance to reproduce before they are caught—we do not allow them to be fished until after the first of July—we are doing more than we could possibly accomplish by artificial spawn culture. We begin this work next week and will continue until the ice covers the lakes. I think this is very much better than any attempt to propagate bass.

DR. OSBURN: Both methods are good. I am disposed to favor the hatchery for certain kinds of planting, but I do not believe we need very much of that in the case of the large-mouth bass, because in the waters in which they are chiefly found, in our smaller lakes, they are taking care of themselves very well. At any time during the five years that we have studied them in the small lakes, one could have taken

millions of young fry for the purposes of distribution without in any way depleting the natural resources of the lake. In the case of the small-mouth bass the situation is a little more difficult in Ohio because we get them almost entirely in the streams; the lakes, aside from Lake Erie, are as a rule too warm for the small-mouth.

MR. TITCOMB: One point that cannot be too strongly emphasized is the seriousness of the depletion caused by the taking out of bait fish by the angler. In some of our lakes the minnows are practically gone, and we have to introduce minnows, along with our other work, in connection with the reservoirs.

DR. OSBURN: That was true around Sandusky and Put-In-Bay this summer; there was no live bait to be had. In the seining about Put-in-Bay harbor for study purposes I could always get some, but not anything like what we should be able to get. Where we could formerly get large numbers of minnows we can now only get a few, so there is no question that there has been a great depletion. It can not be attributed to pollution in streams where no pollution exists. The condition may be due in part to other factors than seining,—the cutting out of shelters and the elimination of the forests, the latter resulting in the streams going so low that they will not maintain even the smaller fish during the lowest water of the season. That is a great check on the production of our small fish as well as of our larger rough fish, suckers and so on, which are no longer found in streams where they used to be abundant. I suppose the same conditions exist all over the country where it is thickly populated.

MR. HARE: Which of the two basses, the large-mouth or the small-mouth, is more susceptible to that parasite which you term the grub.

DR. OSBURN: I have not found any paticular difference in Ohio waters; both are susceptible to it. I do not believe we have as much trouble with it in our state as they do in some Canadian waters, judging by reports.

MR. HARE: Does it depreciate the value of the fish to any considerable extent?

DR. OSBURN: When they are numerous enough they make the fish unfit to eat, but it is uncommon in the waters of Ohio that the fish should, from this cause, be unfit for food.

MR. HARE: Is this parasite more prevalent in warmer than in cooler waters?

DR. OSBURN: I do not think so. I have not made comparisons of this in Ohio, but you will find them both in the small-mouth bass in Lake Erie and in those in the streams in the southern part of the state.

MR. BULLER: May I supplement your remarks in reference to the disappearance of the minnow by stating the conditions which, in our judgment, were the cause of the disappearancee of minnow life from the forest streams in Pennsylvania? It was reported by our officers that bait fishermen who were fishing for minnows would pull up, say, a

bushel of minnows on the sand, pick out what they needed and leave the rest on the sand. We came to the conclusion that that was one of the real causes of the disappearance of the minnows; accordingly a law was enacted to prohibit it.

DR. OSBURN: There is no doubt that much waste occurs, because many of the minnows die and because the larger, breeding ones are taken.

MR. HAYFORD: Speaking of the netting of reservoirs, I have no doubt that in a great many instances good results are obtained, but I would point out that to-day every fish culturist has to be familiar with the raising of bass. When I went to New Jersey there was a good deal of opposition to the spending of money on bass ponds; now each year they are spending more money for artificial propagation. In some of our lakes there is an abundance of fingerlings, but we have a lot of ponds in which we find it very convenient to have artificial propagation. For instance, in the case of one of our lakes the shores were simply lined with large-mouth bass fingerlings an inch to an inch and a quarter long, while in another lake the hatch was very poor; so that we put fingerlings into the lake where the hatch was poor in order to try to keep both going.

DR. OSBURN: That raises a practical point. If bass fingerlings are taken out of a lake, even though there may be a large surplus of them in that water, the anglers interested are likely to raise strenuous objections, because they do not quite appreciate the fact that no damage is done to the fishing in the lake by removing a considerable number of the young. If hatcheries can supply the bass for new reservoirs and for waters that are depleted, the angling population who do not see the scientific side of it is better satisfied. If we could educate them to our point of view, perhaps we would not need so many hatcheries. In the meantime it is better to have some hatcheries to satisfy the angling population.

MR. FOSTER: May I ask Dr. Osburn whether he has ever noticed egg-bound females in any fish other than those from Lake Erie?

DR. OSBURN: Oh yes, we have had them in our inland lakes. We have had them in Buckeye Lake, in the central part of the state. A couple of years ago the anglers were complaining about the law which prevented the taking of fish in the closed season in that lake, because, they argued, these fish would all get hooked by somebody and die anyway. Mr. Wickliff examined a large number of dead bass down from that lake, and upon only a very small percentage of them could he find any marks whatever. When he opened them he found they were adult females egg-bound; they had not been hooked. The fact was that unfavorable weather conditions had caused the loss of a large number of females, and the anglers, seeing these floating on the surface, thought they had died as the result of being hooked.

MR. FOSTER: The reason for my inquiry is this: Two years ago we received at Neosho station a number of adult small-mouth bass from

Lake Erie. The first season they did not reproduce; the second season, when it was evident that they were not going to reproduce, a number of them were opened and we found the ovaries degenerated and in a very bad condition. This was attributed to the larval stage of the tapeworm parasite; the larvae were actually present in the ovaries and also in the intestines. It was very evident that those fish would not reproduce that season, and it is questionable whether they ever would have reproduced. I was wondering whether that was due to a parasitic condition peculiar to those lake waters only, or whether the same thing had been found in other sections of the country.

DR. OSBURN: The larvae of some parasites penetrate quite young and remain there until the fish are eaten by something else; it is their only means of getting out. Whether they would be the same parasites found in Lake Erie I could not tell without examining them.

MR. FOSTER: They were pronounced the same.

DR. OSBURN: You may have the same parasite there, for all I know. Some of them have a wide distribution, but some, I know, are limited to the Lake Erie drainage.

MR. FOSTER: It has been brought out today that many waters which are re-stocked do not need re-stocking, and it has even been deemed necessary to defend the hatcheries in their work. I suggest that an ounce of protection is worth a pound of propagation. I am sure that that principle will hold good in many cases.

DR. OSBURN: Quite right. In many cases we would not need to restock if we would only give a little better protection.

MR. BURNHAM: Mr. Titcomb says that in Connecticut the impression prevails that the large-mouth is more destructive to the young of other species than the small-mouth. In our ponds at Louisville we produce young sunfish in the ponds with the small-mouth black bass, and the bass do not seem to consume the young sunfish to any appreciable extent. In regard to the large-mouth, they do not seem to have reduced the number of young catfish along the Mississippi river to any considerable extent.

MR. CULLER: Can Dr. Osburn say what percentage of the stomachs of large and small-mouth bass that he opened contained catfish?

DR. OSBURN: I have found catfish in their stomachs, but I could not give you the percentage.

MR. CULLER: From the fish culturist's standpoint, do you think it advisable to take the adult fish out of Lake Erie and put them in streams in the southern part of Ohio in which the conditions are not adaptable to them?

DR. OSBURN: The same species occur, of course, in both waters; we have evidence that they do establish themselves in southern streams. In connection with our studies we have seined out fish in the southern streams of Ohio where they had been planted at least a year before, and we know they were Lake Erie fish because they carried special Lake Erie parasites.

DR. EMMELINE MOORE: That is a very interesting point; it might have some application in the case of the depletion of small-mouth black bass around Starve Island. I was going to ask a question this morning on that point.

DR. OSBURN: In relation to the terns?

DR. EMMELINE MOORE: Yes. However, I rise now to ask another question: What foods of small-mouth black bass—crustacean or insect food—do you find most heavily parasitized?

DR. OSBURN: Species of Cyclops, and Hyalella.

DR. EMMELINE MOORE: You do not find the Daphnias specially heavily parasitized?

DR. OSBURN: No.

DR. EMMELINE MOORE: Have you found the larvae of the midge to be heavily parasitized with the round worm? I have found them so occasionally.

DR. OSBURN: Yes, but I have not made any careful studies of the the midge. That is a problem which I hope to take up one of these times.

DR. EMMELINE MOORE: In the course of examination of young small-mouth and large-mouth basses over two successive years, to the number of about fifty each season I found that the fingerling large-mouth black bass were much more cannibalistically inclined than the small-mouth.

DR. OSBURN: That is quite true, and the fact that they grow much faster and are able to take fish food much earlier than the small-mouth is, I think, an important factor when they are kept with other fishes, such as sun fish, etc.

MR. DOZE: Do you find that the small-mouth bass is a longer lived species than the large mouth? The reason I ask is this: we have started work with the small-mouth in Kansas, and we find that our average life of the large-mouth is about ten years. We have got that from development right in the hatchery.

DR. OSBURN: The small-mouth would run about the same age, I should think.

MR. DOZE: What remedy would you suggest for the fungus growth on these fish?

DR. OSBURN: There is nothing that is effective. Individual fish can be cured by salt baths and by use of various germicides, but it is impossible to do that in open waters.

MR. DOZE: Something has been said about closing the season on bass during the spawning period. When the warm weather stage gets well on in August the bass become infected with worms, so that if we pass legislation restricting the fishing in the spring in a large number of states we are going to cut out the only time that the angler can catch big-mouth bass that are fit to eat. It is a tradition in our state that the bass will not bite when over the eggs, and I would like to know

what Dr. Osburn's opinion is on that point. I am referring now to the large-mouth male bass.

MR. TITCOMB: They will bite at a troll right over their nests in the weeds.

MR. DOZE: Do they strike at it simply in anger, or for the purpose of getting food?

MR. TITCOMB: I do not know as to that.

MR. DOZE: I have found that they will not take minnows in the spring.

MR. BULLER: There were sent to my office for indentification about the fifteenth of June seven small-mouth bass, ranging in size from seventeen to twenty-two inches, which had been illegally caught with live bait. Upon opening them we found that three were males and four females. That is evidence that they will take food while they are on the nest spawning.

DR. OSBURN: I would like to ask some of the old hatchery men whether they find that the breeding fish in the ponds take the artificial food the same as the others? That is my conclusion, from what I have seen.

MR. HAYFORD: We find that they seldom eat very much during those periods; if they do catch up food now and then they blow it right out of their mouths. An occasional one may take the food, but as a rule they eat only about ten per cent during that period of what they eat right after they have finished spawning.

MR. BULLER: These fish that were brought into my office were taken directly off the nest. The man who took them was caught in the act and was arrested by one of our officers.

MR. HAYFORD: Two years ago this spring I caught with a plug one hundred large bass right off the nest, to get them for the following spring as breeders. It seemed to me that they bit more in anger than from any desire to get food.

MR. DOZE: We conducted an experiment in one of our hatchery ponds where the water was very clear; we used all kinds of minnows on the male bass, but we did not catch any; we did catch a couple of females. We do not meet very much with the problem of egg-bound fish in Kansas, but we do have cases where the female bass is killed by the male bass. Possibly a good deal of the egg-bound trouble is due to the fact that the numbers of males an d females are not properly balanced; there are probably more males than females.

MR. TITCOMB: The condition of the so-called grubby bass you attribute to the birds, do you not?

DR. OSBURN: It is true that some of them do come from birds; whether or not all do, I could not say. Most of these parasites which we have studied in Ohio are intestinal parasites and those which pass the larval stage in the organs of the body cavity. I am really unprepared to discuss the bird question.

THE SPORTSMEN'S LEAGUE—A NEGLECTED AND UNDEVELOPED POWER FOR CONSERVATION.

By Fred J. Foster
U. S. Bureau of Fisheries, Neosho, Mo.

Fishermen are as a class a patient lot, otherwise they would not be followers of the "Gentle Art", for patience is one of the chief characteristics of a successful fisherman. Perhaps it is due to this abundance of patience and to that other trait, so often found in fishermen, confidence in his fellow man, which has caused him to permit the pollution and depletion of our waters. In days gone by, had fishermen been quick to do battle for their rights, we should not now be facing disaster to the life in so large a percentage of our lakes and streams.

We may thank providence, however, that patience and persistence are usually found hand in hand and when patience ceases to be a virtue, as it most surely has in many of our fish life questions of today, we may expect a militant and persistent corrective effort on the part of this quiet and long suffering brotherhood.

Anger can seldom be condoned but righteous indignation which has for its object the betterment of conditions or the preservation of present favorable conditions is the commendable and powerful incentive which has banded men together for ages.

In union there is strength, but how slow have been the sportsmen to apply this old, old adage to the problems so near their hearts. Those of us who realized the importance of organization have neglected our duty in not devoting more time and greater energy to the furtherance of sportsmen's leagues. Only within the last year has an organization been developed whose aims, ideals and method of functioning are such as to reach and hold the sportsmen of the entire country and those interested in the preservation of our woods and waters.

The American Fisheries Society has and is filling a most worthy and important part in the advancement of fish culture and conservation of fish life but from the general character of its organization, the infrequency of its meetings and lack of state organizations capable of immediate action when necessary, we have not been able to stem the tide of private interests, commercialism and ignorance which has swept the fish from so many of our waters and reduced the

supply in even a larger number. I do not wish to give the impression that the character of our organization or the procedure of our business should be changed, for ours is only a single spoke in the wheel of conservation, which must be maintained at its present strength and efficiency and it would not be advisable for us as a body to scatter our forces. But may we not as individuals give greater support to the local sportsmen's leagues in our communities, under whatsoever name they may be operating and to that national organization, The Izaak Walton League of America, which it is the writer's firm conviction, is destined to play a most important part in the preservation of America's out-of-doors?

There are few among us do not realize the necessity for a militant national organization whose voice is capable of being heard in the national and state capitols, backed by the influence and vote of such a vast army of sportsmen that it will command immediate attention and respect.

National and state executives and legislators are, as a rule, inclined to do what is just and right as soon as they are informed that a sufficient number of persons are interested. The proposed drainage of the famous Winneshiek Bottoms of the Upper Mississippi is a glaring example of the necessity of national pressure.

Many of the states represented here today have superior laws for the propagation and protection of fish, but others,—and I am forced to include dear old Missouri among the latter,—are years behind in either protection or propagation or both; not necessarily because of fault in the initiative or administrative ability of the Fish & Game Commissioners, but because there has been no concerted strength and man power behind their recommendations.

One can hardly imagine the laws of a state permitting the gigging of a 10½ pound rainbow trout from her spawning bed, and at the same time prohibiting the taking of this species with an artificial fly months after the close of the spawning season, yet this is exactly the condition in Missouri today with other laws even more destructive because they adversely effect the native fish found in the majority of the waters of the state. With proper organization of the sportsmen such laws would soon be replaced and all game fish protected during the spawning season; a size limit permitting a fish to have reached maturity and to have spawned at least once before being put into the frying pan and a creel limit that would prohibit the killing of 110 bass in one day as accoplished by a certain sport—not sportsman—from Kansas City this past summer.

This in turn leads to another most important duty and privilege of the sportsmen's league, that of educating the general public and our boys and girls, particularly, in true sportsmanship and the necessity for conservation. Do I hear someone ask why the girls are included? If for no greater reason than that some of our sons may enjoy at least one vacation in three with a wife who is a companion in God's out-of-doors as well as at White Sulphur.

Much good can be accomplished by enlightening sportsmen to the necessity of exterminating the natural enemies of fish, such as snakes, turtles, undesirable fishes and fish eating birds and animals. The sportman takes his toll of fish but a few days, a month or season but the natural enemies are present for months at a time or throughout the entire season and the damage done by them would equal the combined output of many hatcheries.

Sportsmen are eager for more knowledge as to the life history and methods of propagation of their beloved finny tribe and all the multitude of aquatic creatures that are related to them and the conditions which govern their existence. If we will but take the time to say a few words at Sportsmen's League meetings and impart a small fraction of the knowledge we possess, be it scientific, fish cultural or commercial, we will be repaid by the thanks of the most attentive and appreciative audience one could wish.

The American Fisheries Society is organized, "To promote the cause of fish culture; to gather and diffuse information bearing upon its practical success and upon all matters relating to the fisheries: to unite and encourage all interests of fish culture and fisheries; and to treat all questions of a scientific and economic character regarding fish." Yet beneath these words is a hidden and greater meaning which might be expressed as follows: To pass to the coming generation a greater knowledge of matters piscatorial; to maintain the fight against commercialism and ignorance that idealism may not perish and the human race may not degenerate to a mass that knows not God in nature.

How much clearer life is seen from the porch of the little log cabin overlooking the clear, swift waters of a stream which winds its pleasant way through wooded Ozark hills, than it appeared a week before amid the strife and sham of city life.

The American Fisheries Society and the Izaak Walton League of America, in their efforts to maintain fish life in the waters of our country, are striving not alone to give recreation and health but to maintain that even balance in the hearts and minds of men so ably expressed in Edgar A. Guest's poem entitled "Out Fishin' ".

Discusssion.

MR. JOHN P. WOODS: A year or so ago a chapter of the Isaak Walton League was organized in St. Louis, and I was honored with the office of President. Within a few weeks I found it necessary to go abroad with my famiily, and therefore could not give to the work the attention that it deserved. On that account I resigned the presidency, but I have not by any means lost interest in the work of the organization. Were it not for the fact that I am Chairman of the Resolutions Committee I would be willing to present a resolution to this meeting endorsing the work of that splendid organization. (Applause.)

PRESIDENT LEACH: Someone may have a resolution to offer to the Resolutions Committee on that subject. Is there any further discussion of this paper?

MR. C. M. BASKETT (St. Louis) : I have been busy for the past five and a half months organizing chapters in the State of Missouri for the Isaak Walton League of America. In a period of fifty-five working days we have instituted thirty-five chapters in the State of Missouri. I have pledged the National Board one hundred chapters. This movement is sweeping over the country like wildfire. Kansas is crying for it; I organized a couple of chapters there a few weeks ago. Every state wants it; it is the only thing that is going to save the day.

MR. AVERY: What Mr. Baskett has said is wholly true, and he has merely touched upon the subject. The sportsmens organizations, of which the Isaak Walton League is the most powerful example in the country to-day, are going to do what he predicts. But this Society is just as necessary as any other organization. The American Fisheries Society is not a society for propaganda, not a Society to arouse the people or to get legislation, as these other institutions and organizations can do. I want to make this suggestion to Mr. Baskett: every chapter of the Isaak Walton League ought to take out a club membership in this Society. If there are seven hundred chapters and they all took out memberships in the American Fisheries Society, the Society would be placed in a position to finance its work. This is a learned Society; its purpose is investigation and scientific research, things which are absolutely necessary to supplement the work of such organizations as the Isaak Walton League, no policy, no code of laws which is worth a cent, can be adopted in this or any other State or in the United States as a whole unless it is based on actual knowledge, upon scientific facts which this Society is accumulating. Therefore I believe that the Isaak Walton League could do nothing better than give its support to this Society.

MR. CULLER: I am a member of the Isaak Walton League, I am proud to say. In connection I may point out that if the Winneshiek bottoms, of which Mr. Foster spoke, are saved, it will be due only to the Isaak Walton League, through Mr. Will Dilg, who made a personal inspection of that country and who has written on the subject on a number of occasions, and to a local chapter of the Isaak Walton League in Iowa which arranged for funds to carry the case to the Supreme Court of Wisconsin, hoping to gain time so that these bottoms could

be properly taken care of. I hope to see the day when the Isaak Walton League will be the greatest organization of sportsmen in America.

MR. FEARNOW: The Bureau of Fisheries has dealings with over two thousand different organizations, under various names. We have the Isaak Walton League of America, the various Fish and Game Associations, the United Sportsmen's Club, and so on. These organizations are all of inestimable value in connection with our work; without their aid we could not accomplish more than two-thirds of the work we are now undertaking. Fish which we furnish to applicants are delivered at railroad stations; when we have done that we have fulfilled our part of the contract. Representatives of these Associations meet our messengers at the railroad stations, divide the fish up into small lots and carry them to the headwaters of streams away back in the mountains. It would cost the Bureau about as much to do that part of the work as it does to propagate the fish and deliver them at the railroad stations. The importance, therefore, of the work that these organizations have been doing in the matter of fish distribution cannot be over estimated. Moreover, I do not know where we could get from any other source the valuable information which they furnish to us. They know every little headwater; they know the right place to plant the fish so as to get the maximum results. We should do everything possible to encourage the formation of organizations that have in mind the protection of fish or the fostering of the fish supply in our streams.

MR. BASKETT: I hope that Mr. Avery did not think I was in any way disparaging scientific research. I am greatly interested in it. But in the State of Missouri alone there are more than fifteen or sixteen hundred "hill-billies", and they are the boys we have to educate. They care nothing about your scientific meetings; but they know what they want and are out to get it. When you can educate that chap down there on the Niangu, the Current or the Black river that he is not to dynamite fish; that he is not to gig fish in or out of season—the law will be changed in Missouri. When you teach him that he is to quit shooting with high-powered rifles and violating the game laws in various ways; when you can impress that upon him, we are going to have more fish in the streams and lakes of the United States. This is the work we are endeavoring to do; we have to reach these fellows. We have to put it to them in their own vernacular. I have fished and hunted among them for years, consequently I am having more success in these endeavors than I otherwise would. I have come here to ask you gentlemen to co-operate with the Isaak Walton League of America in its great work, and from the remarks that have been made I see that co-operation is here.

PRESIDENT LEACH: The Isaak Walton League of America fills a long-felt want. It meets the sportsmen and fishermen all over the country; it speaks their own language. The League will have the co-operation of the American Fisheries Society. Mr. Will Dilg is an organizer; he has a large number of enthusiastic men behind him. Every body should read the monthly publication that he publishes.

MUSEUM METHODS IN RELATION TO THE FISHERIES SOCIETY

By T. E. B. Pope
Curator of Zoology, Public Museum of Milwaukee.

The modern natural history museum is not in the fish-hatching business, nor is it concerned in any financial or other way with the commercial fisheries, but nevertheless it is intensely interested in both of these directions as will be briefly shown. It is, therefore, greatly concerned with the proceedings of this Society and other allied scientific bodies that are endeavoring to promote and encourage the proper conservation, production and utilization of the natural history resources of this country.

If I should be asked as to the relationship that is so claimed to exist between the modern museum that includes natural history exhibits within its walls and the fisheries industry in all of its phases, my answer would be that it serves as a sort of public clearing-house between the society concerned and the general public; it serves, or can well be made to serve, as the medium for the tangible and actual illustration of the results achieved in the field of production and is in reality an agent, exponent, or publicity-medium for the fishery and other allied societies.

Let me now briefly attempt to illustrate by a few facts and wellknown examples, some concrete evidence of the claims so made. To do so I will be obliged to roughly outline the methods of a modern museum in this important relationship to the Fisheries Society. The evidence I believe will speak for itself.

1. *The modern museum does actually serve or can be made to serve as a direct agent between yourself and the people at large even though its services as such have hitherto not been solicited or openly considered in that capacity by you.*

Despite the numerous papers that have been submitted and read before this body on the identification of species, nomenclature, apparatus, transportation, legislation, conservation factors, resources, etc., etc., the major number by far have been directly concerned with the problems, methods and various phases of production. To a large extent this society has been recognized as a society of fish producers and the most active participation in its meetings have consequently been by public officials of the Federal Bureau, of state hatcheries, state fish commissions, and conservation

appropriations for their work in turn has been, and is, dependent upon the support, approval and enthusiasm of the people's representatives to the Federal and State legislatures. These representatives again are influenced and stimulated to support, or to cease to support, fishery appropriations in accordance with the trend of public sentiment. Public sentiment finally is entirely based on the factors of necessity for the service, public welfare or desirability, and the practical results obtained. "The proof of the pudding is in the eating." In other words, if the actual results of fishery production are not sufficiently adequate, or can be demonstrated that they will be within a reasonable period of time, then there always is the natural prospect of greatly reduced appropriations, or, worse still, an absolute discontinuance of the entire service. It naturally stands to reason that appropriations will not be continued unless tangible results are forthcoming even though the necessity for and the objects of the service are of the most laudable character. Public interest and continued support of the service, therefore, hinges upon the public knowledge of the tangible results of the service.

This public knowledge of tangible fishery results at the present date has been almost wholly restricted to the numerous and voluminous reports, bulletins, and other publications of the Federal and individual State Governments, including their respective departments (which although free for the asking, are rarely obtained or read by even the mass of the intelligent people); to the knowledge of citizens in scattered local communities where hatcheries are situated (even this local knowledge is often not only inadequate but negligible as far as the mass of the country's citizenry is concerned) and also to a less extent to the irregular, and comparatively few circulars issued by conservation commissions. It is, therefore, safe to say that the average citizen knows practically nothing about the methods and actual results of the fishery production service and the continued support to the service is consequently left to the various state and Federal legislators who may or may not inject petty politics into the system or decrease appropriations.

For some time, there has been a public institution that has a decided interest in matters that you are concerned in, —that is, all matters that are connected with the necessity for, the production of, the distribution, the proper legislation for, and the conservation of fish life. It is the public natural history museum. Conditions have radically changed in the last ten years or so in the policies and exhibition methods of museums. Only those persons that visit them frequently or keep directly in touch with their work can realize

the full significance of the great changes that have transpired in later years. No longer is such an institution only a permanent storehouse of varied specimens, no longer is the system of 'upholstering' and relegating objects to dusty shelves forever, in vogue, etc. On the contrary, the progressive museum is today rapidly becoming an educational power in the community and a broad-casting station through the means of carefully prepared exhibits of value (involving the most improved methods of technique of skilled technicians) and free illustrated lectures on almost every topic connected with the animal, plant and geological resources of the country. It is directly in contact with the people, and, with possibly the exception of the public library system, the progressive museum with its exhibition halls and free, numerous, illustrated lectures directly 'rubs elbows' with a greater mass of the people annually perhaps than any other educational or other public institution. Such an institution is rapidly becoming the official headquarters of the people in numerous large cities for the accummulation and broadcasting of knowledge on all matters pertaining to the biological and geological resources, as well as other subjects, within its scope. Its information, handed out in manifold ways, is popular in form, within the understanding of the average citizen, it is not clothed and tainted with the pedantry of the university class room and laboratory. Again, unlike the books of a library or the wearisome, dry, statistical pages of a public document, the information is brief, digested down to the practical, ultimate facts and presented to the public from the public lecture platform by word of mouth, with stereopticon, with motion-film, printed on specimen labels and in other forms. Further, this information, unlike that of any other institution, is materially supplemented by actual specimens of the fishes or other objects under consideration, by actual apparatus, photographs, charts, diagrams, models, etc., connected with the same. For the proper dissemination of the tangible results of the fisheries service, it may be here stated that all of the important and salient facts are carefully 'culled out' from the latest documents when received, the proceedings of such a society as this are digested to obtain the most recent improvements in methods and the final results in popular form up to date are printed upon the museum specimen labels, incorporated in public lectures and broadcast to the public at large. Thus it will be readily seen that the modern public museum is constantly radiating 'daylight' on matters that concern the public pocketbook, of which the average citizen has hitherto been ignorant of, unable to get authentic knowledge of, or understand. By the same token it will be seen

that the modern progressive museum is, as has been claimed in the early part of this paper, serving as a direct agent between yourself and the people at large even though its services as such have hitherto not been solicited or openly considered in that capacity by you. "Constant dropping of water may wear away stones," so the saying goes, and in like manner the continual process of popularly enlightening the public on your methods, objects and actual results, by disseminating such information annually to hundreds of thousands of people through the exhibits and lectures of a single institution alone will no doubt sooner or later have a decided effect upon the sentiment of the people and not improbably affect your necessary annual appropriations. In short, it is becoming universally recognized that such public institutions can and do possess the power to considerably mold public sentiment along the directions already mentioned.

2. *The modern progressive public museum serves as the people's headquarters and agent for information within its scope.*

Inquiry will develop the fact that the United States alone has hundreds of museums of all types, but that among them, from the Atlantic to the Pacific, are a number of general museums dealing with natural history that are well scattered among the larger and most densely populated communities. In recent times the tendency seems to be for the establishment of public museums just as for public aquaria. It is perfectly natural therefore that, in any community possessing a natural history museum, such an institution should be regarded as the official headquarters of the community for information within its scope and to it the general public and newspapers go with every possible kind of inquiry on natural history. Should I attempt to elaborate upon the number and nature of such inquiries and demands that include all phases of fishery production, care and conservation ranging from the remedies for goldfish diseases, or the identification of local fishermen's captures to the interpretation of Government statistics, you might be both interested and amused. Obviously you will see why the modern museum is unlike its predecessor in policies and exhibits. In the old days the people appeared to be satisfied with the well-known systematic collections of animals and other objects placed in tiresome array upon shelves with only a Latin name upon a piece of pasteboard to differentiate one specimen from another. Now such methods are decidedly out of date. The people want to see the various forms of life represented in natural environment to show their relation in nature, one

to the other (called by us Habitat Groups). They want also exhibits to show the usefulness of these many fishes, birds, reptiles, insects and other forms of life to man, if such have an economic value; how they are obtained or captured, what is the economic status of the animal, and how it is converted into a useful purpose by man, etc., etc. The people now want something for their money. They want the best of exhibits, lectures, and, above all, they want the latest and correct information. And the modern progressive museum is keeping up with the times. It now possesses, in the case of all the larger institutions, the staff and facilities for gathering of suitable exhibitional material, the proper installation of the same and the broadcasting of popular information. That the people of a community do want such an institution, can support it financially, as well as back it up with actual attendance and encourage its development, allow me to cite you the concrete example of the Public Museum of Milwaukee. The museum is general in scope, it is ranked as about fifth in size of all museums in the country, even though the city only occupies the position of thirteenth in population. In actual attendance, by the same method of computation as employed by all other museums, it ranks second, with an annual attendance of approximately 750,000, thus being next to a famous New York City institution. This attendance places the museum in the enviable position of being the only institution of its kind in the country whereby the annual attendance is greater than the entire population of the community in which it is located. This fact is of no little significance when it is remembered that the city is not noted for its 'sight-seeing' advantages and therefore such abundant support is of local nature and comes entirely from the people that support it financially and not from transient patronage. Its public free lectures were attended by close to 100,000 last year and that figure is on the increase for the present current year. These facts are not incorporated in this paper with any intention to advertise the institution (because it already draws adequate support, as shown, in its own local community) but simply to offer a concrete example to the claim made above, namely, that the public natural history museums of the country, either individually or collectively, are in a position to promote considerable sentiment and dispense information on subjects under public control as represented by fishery production.

3. *The modern progressive public museum has the facilities for promoting the cause of the American Fishery Society and allied scientific societies.*

Needless to state, the average natural history museum possesses a systematic collection of fishes. In addition to that, the Milwaukee Museum has initiated the nucleus of an Economic Fishery Collection in which it is planned to ultimately include all of the economic food and game fishes of the country, these to be supported by as complete a collection as possible of all apparatus used in their capture, of the products and byproducts that come from the same with ample charts, photos and models to illustrate the fishery methods and commercial processes. Such a collection is explained in the copy of the Museum Yearbook submitted for your reference.

In a museum of this kind is, therefore, the opportunity for the installation of fish-cultural apparatus and exhibit material, photographs, explanatory charts and diagrams, models and all else that serves to publicly explain and illustrate the cause of the fish-culturalist and conservationist. Legal and illegal apparatus could be exhibited with brief popular descriptive labels that tell the aims and story of the conservation commissions. In fact, there is today hardly any useful public cause or occupation that is not conducive to illustration through exhibits. But the material must and should come directly from the interested parties themselves if they would desire their own field of endeavor with its aims, methods and tangible results to be more adequately and intelligently presented to the people. The modern museum is therefore in a position to encourage, foster and promote the fishery industry but it should have active support from the interested scientific societies.

CONCLUSION

In conclusion, therefore, allow me to state that our public natural history museums, our fishery colleges (as represented by the Seattle Institution), our commercial museums (as that of the Philadelphia Commercial Museum), and all other similiar institutions of this country and Canada do actually serve the fishery and allied causes and that active cooperation between these institutions and the various societies concerned cannot be too strongly emphasized.

Discussion.

MR. DOZE: At Topeka recently they had a free fair; a pavilion was built for the Fish and Game Department and we exhibited fish there. I was told by those connected with the fair that this exhibit was the most popular place in the grounds; there was not a time when the people were not gathered three or four thick around the exhibits. We took advantage of the opportunity of handing out literature published by the Fish and Game Department, with suggestions in regard to organizing local

sportsmen's associations. Since I have heard from the gentleman from Missouri speak of the Isaak Walton League I think we shall change these to Isaak Walton Chapters, and if he comes over to Kansas we will help him organize.

DR. OSBURN: The experience of the gentleman who has just spoken is the same as ours in Ohio in connection with our State fair. For a number of years we have had an exhibit of fish and game, including a small aquarium, and that place is literally packed during the whole week of the fair. An exhibition of this kind is very important from an educative point of view. A great many people from outlying districts attend these fairs where they could not get this information in any other way. Many who do not know one fish from another are found standing by the tanks, carefully reading the labels and examining the fishes, Another thing that has been a feature there for years is an exhibit of illegal apparatus.

The public museums and the aquaria of the country are very important in that they offer the kind of education the people need. This phase of education might be further augmented by a display of hatchery methods. I do not know whether or not Mr. Pope's museum has undertaken that, but at the New York Aquarium for many years a small model fish hatchery has been exhibited, and has always attracted a great deal of attention.

I believe there is no better way of getting information to the public than through the medium of sportsmen's organizations. We never can get legislation which is backed up by the people—and unless this is the case it is not of much use—until the people get the information before them, and the best way to do this is through such organizations as the Isaak Walton League. Members of this and other sportsmen's associations are always willing to get behind any movement in favor of conservation, not only of fish but of other resources as well. (Applause.)

MR. DOZE: As a result of this display at Topeka, Wichita has borrowed the idea and built a number of aquaria. Furthermore, next year we are going to make a similar exhibit at the State fair at Hutchinson, so that the exhibit will be made at three different places in succession.

PRESIDENT LEACH: Education of the people is necessary if you want them to take an interest in such organizations as the Isaak Walton League and the American Fisheries Society.

ARE WE MAINTAINING THE SUPPLY OF WHITEFISH IN LAKE ERIE?

By S. W. Downing,
Put-In-Bay, Ohio.

I was asked to write a short article on whitefish, and it was suggested that particular mention be made as to whether or not our work of propagating this most excellent food fish is resulting in maintaining them in as great numbers in Lake Erie as they were previous to the time the work was undertaken.

At first thought this appears to be a very easy subject to write upon, but in preparing these few thoughts, I find it to be rather difficult to bring out the ideas and make them comprehensive. However, we will begin with the assertion that we are not only maintaining the original number, but that we are materially increasing it, and this in spite of the great activities of the commercial fishermen who are taking them in the largest numbers possible to supply the demand for them as food fish.

Beginning as far back as the first year that the federal hatchery at Put-in-Bay, Ohio, was put in operation in 1890, and continuing from that date up to the year 1899, the annual collection of whitefish eggs from the same fields operated since that time, ranged from eighty to two hundred millions. (This record is not complete but from the data at hand we believe this number to be fairly accurate.)

The fields from which the eggs were collected are as follows: Monroe, Mich., and in Ohio, Toledo, Port Clinton, Catawaba Island, Kelley's Island, Middle and North Bass Islands and Put-in-Bay Island, so called.

The collection of whitefish eggs from these fields during the twelve years from 1900 to 1911 inclusive, yielded a total of 2,658,486,000 eggs, or a total average of 223,498,000 each year. During the next six years, from 1912 to 1917 inclusive, they produced a total of 2,567,690,000 eggs, or an average of 427,948,000, eggs, which shows an average annual increase over the preceeding twelve years of 204,450,000 or nearly double the number produced each of the first twelve years.

During the last five years, from 1918 to 1922 inclusive, the Ohio State Fish Commission operated the Kelley's Island field and a part of the Put-in-Bay field and the U. S. Bureau

of Fisheries operated the balance of the original area, and the total collection by both was 2,917,350,000 or an average of 583,470,000 each year; showing an average annual increase of 155,522,000 eggs over the collections of the six years immediately preceeding, and a yearly increase of 358, 972,000 over the first twelve years considered, or more than two and one half times as many from the same area.

Now as this is an assembly of persons more or less interested in fish, and fish culture and the method used in the work, it is taken for granted that most of you here are familiar with our work up on the Great Lakes, but for the benefit of those who are not, I will say:

Our entire work is strictly that of conservation, as we neither catch or destroy any of the fish from which we secure our stock of eggs for propagation. On the contrary all the eggs of all the species propagated by us are taken from the fish caught for market by the commercial fishermen and would have gone to market with the fish and been a total loss to production had not we secured them for propagation. Now as we secure our stock of eggs from the fish caught by these commercial fishermen, it goes without saying that the supply of eggs naturally must correspond to the number of fish taken by these commercial fishermen, and therefore if the number of eggs secured by us has steadily increased during all these years there must have been a like increase in the number of fish caught, which we think will conclusively prove to you that our assertion that we are maintaining the number of whitefish in Lake Erie, is true.

Now this may seem to be a very short paper, and it is, considering the importance of the industry under consideration, and I will therefore touch upon another phrase or angle of the subject, not so much with an idea of proving any thing as to introduce the matter for discussion.

From the year 1900 to within a few years since, the Monroe, Michigan, field, the most westerly of all our stations, was very productive, producing the great number of 306,000,000 of eggs in the year1913, but since that time the collection at that point has gradually dropped off until since the year 1919 we have not been able to secure any eggs at all, and the take of fish by the commercial fishermen has declined to such an extent that some of the firms operating in this vicinity have purchased no new nets to replace those worn out, believing that the fishing on these grounds has become permanently ruined.

While the conditions at Toledo, another of the fields at the extreme west end of the lake, are not quite so bad, the catches of fish, and consequently the take of eggs, has ma-

terially diminished, having dropped from 82,560,000 in the fall of 1914 to 15,600,000 in the fall of 1922, the decline being steady, with the exception of the fall of 1920 when the number reached nearly 54,000,000.

Now the question is why? What is causing this decline at the west end of the lake while the take of both fish and eggs is increasing farther east or down the lake from these fields mentioned? The take of whitefish eggs at Kelley's Island, one of the most easterly fields has steadily increased during this time, why? We believe that the reason for these changes is on account of pollution. What do you believe?

Discussion.

MR. TITCOMB: Have you any statistics of the whitefish catch during any of these years?

MR. DOWNING: No, I have not.

PRESIDENT LEACH: The State of Ohio, I believe, collects statistics on this point every year. The commercial fishermen are required to furnish the necessary information, and that is made a matter of record at Columbus. The Bureau collects statistics out there about every five years; it just completed one last year.

MR. DOZE: Is the pollution any greater at the upper end of the lake than at the other?

MR. DOWNING: Since the establishment of large powder factories near Monroe at the upper end of the lake and the dumping of their refuse into the water, the catch of fish has very materially dropped. At Toledo they get the pollution from the Maumee River, which drains a large section of the country; and there is all the sewage from the city of Toledo.

MR. TITCOMB: We have many organizations throughout the country which are interested in this matter. We have the Anti-Pollution League, which is to meet at Atlantic City in October; and there is another meeting at Pittsburgh preceding that. We have the league with reference to migratory fish, and we have this most recent acquisition, the Isaak Walton League, which has come to be so powerful. Every one of these organizations should be working to help the Bureau of Fisheries to get appropriations to do intelligent work; and none of them can accomplish a great deal if they are not intelligently directed. The Isaak Walton League has to have the assistance of this Society and of the Bureau of Fisheries. It is possible to know definitely whether the disappearance of the whitefish in certain sections of Lake Erie is attributable to certain causes it can be worked out by the Bureau of Fisheries if they have proper support and the money to do it with. This is only one of the things which these organizations ought to take hold of and push through. A man like Carlos Avery, recognized as one of the leading conservationists of the country, can be put out of office and a politician put in his place. Much of the work he has done is upset; no man, however good he may be, can learn in fifteen years what Carlos Avery knows. This is a chance for the anglers' league; and the anglers' league has to work with the commercial fishermen, otherwise the work they are trying to do may be blocked.

THE FUTURE OF THE FISHERIES OF THE PACIFIC

By John N. Cobb,
Director, College of Fisheries, University of Washington.

"Westward the Star of Empire Takes Its Way."—*Berkeley*

When the poet wrote the above line, he little recked how soon they would come true, especially in fishery matters. First the Atlantic Coast of North America wrested the fishery preeminence from the old world, and for many years our fishing vessels, manned by the hardiest and most daring fishermen the world had seen up to that time, plowed the seas from the ice-bound fastnesses of the Arctic to the even more difficult ones of the Antarctic.

As time went on, and the shore of the Pacific gradually became peopled with the hardy pioneers of the East and Middle West, including also some of those who had participated in the later stages of the wonderful development of the Atlantic fisheries, and the descendants of others, the infant fisheries of the Pacific began to attract attention. Starting with the salmon, our fisheries steadily increased in value and importance until in 1919 they exceeded in value and quantity those of the Atlantic seaboard, and unless all the teachings of history are at fault, they will never again be distanced by that section of our continent. If we are ever to lose our supremacy it will be because the course of empire has continued its way to the westward and the preeminence rests with the Asiatic side of the Pacific.

Around the shores of the North Pacific are at present to be found the most important commercial fisheries in the world, and also the greatest undeveloped fishery resources of the known world. The Mexican and Central American fisheries on the Pacific have been but slightly developed; there is room for a large expansion of the present fisheries of the Pacific States, Alaska and British Columbia; Siberia's vast fishery resources (both marine and freshwater) have hardly been scratched as yet; the marine resources of Korea and China are largely in an undeveloped state while Japan, one of the leading fishing countries of the globe, is still holding her own. It has been estimated that the fisheries of the sections bordering on the Pacific amounted in value in 1918 to $325,665,000.

With the exception of Japan, none of the countries bordering on the North Pacific has exploited its fisheries to anything like the extent that is practiced in the fisheries of the North Atlantic. Most of our efforts in each section of the Pacific have been centered upon a few well known species, while the lesser known ones have been almost entirely neglected. A typical example of this is the albicore. In 1907 Dr. Jordan stated "the flesh of the albicore is of little value, unless, as in Japan, it is eaten raw." That same year, Mr. A. P. Halfhill, of San Pedro, California, discovered a method of canning them, and as a result a large canning business, amounting in 1919 to 657,624 cases, was built up. About 1903 the canning of sardines began on the Pacific Coast, but it was not until the war created a large demand for food products that the industry became important; the pack in 1919 (a dull year as the result of the ending of the war in November, 1918) amounted to 1,151,516 cases. Prior to the opening of the war, the largest pack of pickled food herring in our Pacific territory amounted to only about 15,000 barrels. In 1922, we pickled for food nearly 200,000 barrels, and this could be expanded enormously had we accurate information as to the migrations of this species.

Cod.—The oldest fishing industry by Americans in Alaska is that for cod, this having been started some years before the territory was purchased by the United States. The principal off-shore cod banks in the North Pacific extend from Middleton Island, in the Gulf of Alaska, to Unimak Pass, and in Bering Sea, from Unimak Pass to Cape Newenham. These banks comprise some 30,000 square miles. In addition there are what are known as inshore banks, mainly worked by the shore stations and which lie between the offshore banks and the mainland shore. These comprise an area about one-half as great as the offshore banks. In Southeast Alaska considerable cod is also found, while there are good reasons for believing that important offshore and inshore banks exist on both sides of the Aleutian chain to the westward of Unimak Pass.

The fleet operating on the offshore banks in1921 comprised some 19 sailing and power schooners, while 17 shore stations, equiped with launches and dories, operated on the inshore banks. The total catch amounted to 4,787,831 cod, valued at $457,320. This catch could be enormously increased, and the only reason why this has not been done has been because the Atlantic banks continue as heavy producers, and our fishermen find it difficult to compete in South and Central American markets with the Atlantic coast dealers who have controlled this trade for nearly 200 years.

The present insignificance of the local fleet may be gauged by the fact that the cod banks in the Atlantic off the American continent are less in extent than ours, and yet they give employment to over 2,000 vessels, and this in despite the fact that they have been fished continuously since 1502.

Trout.—The fresh and salt waters of the Pacific Coast are infested with hordes of Dolly Varden trout, and some day the preparation of these for market in a fresh, frozen, pickled and canned condition will be a big industry. At the present time but little use is being made of this species.

Miscellaneous Fish.—In our waters are to be found many species but sparingly, or not at all, used as food and among these may be cited silver hake, atkafish, various species of flatfishes, "ling cod." Sitka "black bass," whitefish, Alaska pollock, the various rock-fishes, etc.

Fish Offal.—Thousands of tons of fish offal are thrown away every season at the fish canning and other plants in Alaska. A very small fraction of this valuable material is at present saved, and oil, meal, and fertilizer prepared, but this production could be increased a thousandfold were an effort made.

Included in this offal are tons of salmon eggs and salmon melt. These, if properly prepared, would make excellent food.

Clams.—The clam resources of the North Pacific are enormous and it is only within the last 8 years that any serious attempt has been made to exploit them, and this only in one or two small areas. Most of the clams utilized were canned, some thousands of cases being so prepared this year.

Oysters.—The oyster production of the Pacific Coast ought to be almost as great as that of the Atlantic. As a matter of fact it is not more than a fraction of the quantity produced in the latter region. This is due largely to the fact that the growers have received almost no assistance from the federal government in working out the problems peculiar to this coast.

Shrimp and Prawn.—The shrimp and prawn industry of Alaska at present is centered around Wrangel Narrows, and produced in 1921 products to the value of $132,077. Shrimp may be found in many other sections of Alaska and as time goes on these supplies will be used quite extensively. They are also said to be exceedingly abundant off the Siberian coast, and are only occasionally used for food.

Aquatic Mammals.—The north Pacific has always been a favorite resort for aquatic mammals, and many whales, (finbacks, sulphur-bottoms, humpbacks and belugas) are to be found in their season, while porpoises, hair seals, sea

lions, and walrus are present in countless numbers. Several stations are now being operated in Alaska in the catching and rendering of whales. Oil, meal and fertilizer are the usual products obtained, but each season witnesses a steadily increasing demand for the meat as food in either a fresh, frozen or canned condition, while a market has of recent years been found for the hides of aquatic mammals in the preparation of a high grade of leather.

Crabs.—Operations during the year 1922 indicate that the canning of crab meat is now an established industry on this coast, as some six or seven plants were operated. The pack was comparatively small, and this is due to several causes—the fishermen have not yet become familiar with the habitat of the spider crab, the best and most profitable crab to can; the duty of 15 per cent on imported crabs does not furnish enough protection to our packers, while in some instances local methods of packing are susceptible of considerable improvement. One of the first pieces of research work taken up by the College of Fisheries of the University of Washington after its establishment early in 1919 was the working out of a process for cooking crabs and canning the meat, and this was published in the *Pacific Fisherman* of June, 1921. At the College we still have some of the original pack, now a little over two years old, and whenever opened these present a pleasing appearance, and in all cases have proved sterile. When put up properly Pacific crab meat is a delicious article and one that not only pleases the eye but also the palate.

Most of the meat packed so far has been of the Dungenese crab (*Cancer magister*), the common crab of this coast, and which is found in the shallow coastal waters from Monterey to some unknown point in Alaska, probably Cook Inlet. This crab is a favorite in the markets of our coastal states, where it is sold mainly in a boiled condition. Attains a maximum weight of about five pounds, but the average weight is about one and one half or two pounds. They are taken in oblong pots, similar to the common lobster pot of the Atlantic, or in open collapsible pots like waste paper baskets when distended.

The fact that the spider crab has a whiter flesh, while the red stripes on the outside of the leg meat is more brilliantly colored than that of the Dungenese crab, has led our packers to institute a search for the former in our waters, and so far it has been reported from the neighborhood of Wrangel Narrows, in Prince William Sound and Cook Inlet. In the last named place, two canneries began catching and packing them last fall, and the produce turned out compares very favorably with the best of the Japanese pack.

What little knowledge we have of the spider crab is to the effect that it is a resident of our deeper coastal waters, and it is probable that it will be found all along the outer coast, and possibly in certain of the straits and sounds of Southeast Alaska.

MANY UNSOLVED FISHERY PROBLEMS

It is surprising how little we know of the life histories of the aquatic animals of the Pacific. This is especially true of the migrations, etc., of the herring, halibut, tuna, albacore, mackerel, and other species, of the Pacific, and when the life history of these has been worked out, I hope to see an immense extension of the herring fisheries, and a lesser expansion of the others.

We have but fragmentary surveys of the fishing banks. Most of this work has been done by the "Albatross" on the occasions when she was not otherwise employed. The surveys were exceedingly meager, the data and material collected very slight in quantity, while large areas that our fishery people were interested in were not covered. It is my belief that the cod banks off the Alaska coast extend much farther to the westward than the government surveys indicate; that the known banks are much more extensive than are plotted; and that halibut will be found to extend much farther to the westward than is now supposed to be the case.

Small power vessels of the type used in halibut fishing, would be ideal for making such surveys. The type has been developed to fit the peculiar conditions prevailing in the North Pacific ocean, and as they are extremely economical to operate, the expense would be kept to a minimum.

As we are far from many of the consuming markets of the world, it is necessary that we prepare most of our products in such a manner that it will be possible to hold them for considerable periods of time, and also that they will be in proper condition to be shipped to far distant markets. Canning more nearly fills these requirements, but it is not feasible with some products, while with others, the consumer demands them either fresh, frozen, or pickled, in preference to canned.

There is a wide field for the working out of the methods best suited to the preparation of food products from the many hitherto neglected, or but little used, aquatic species found in the Pacific. Up to two years ago, this field was almost totally neglected, and even today but little active

work is being carried on.. It is hoped to devote our equipment and a considerable part of our time, at the College of Fisheries, to research work on the best methods of canning, pickling, dry-salting, drying, freezing, and smoking fishery products. A start has already been made along this line, but, unfortunately, the lack of funds for carrying on such work is already hampering our efforts.

EDUCATION IN FISHERIES.

The earliest of the nations to appreciate the need for proper training of its men in fisheries was Japan. In 1889, the Fisheries Society of Japan established the Fisheries Training School for the sole purpose of training young men to be future organizers and managers of the fishery industries of Japan, but since the time of its transfer from the society to the Imperial Government in 1897 the investigation and experimental work pertaining to the fishery industry has been added to its original scope.

The work has since been enlarged until in addition to the Imperial Fisheries Institute there are six local fishery institutes, and various schools of grammar and high school standing, giving Fishery education throughout Japan.

In these strenuous days, when nation is competing with nation for commercial supremacy, it behooves each to make use of the very best intelligence of its citizens, and as a result the nation that furnishes its citizens the best training along economic and vocational lines will undoubtedly forge to the front.

In 1919 the University of Washington established a College of Fisheries, the only fully equipped one in the world outside of Japan. In addition to the regular four-year curricula leading to a degree, provision has been made for special students who show aptitude for the work, but who have not had the preliminary training requisite for regular admission to freshman standing. These students may secure this in the University and thus become regular students eligible for degree if they wish. An exceedingly important feature is the series of short courses offered in the various branches during the winter quarter, and which are open to any person who understands English, is 20 years of age or over, and who indicates ability to carry the work with profit. Most of those attending the Short Courses are regularly employed in the industry. They come for the purpose of enlarging their knowledge of the fisheries.

Through the generosity of the manufacturers of canning machinery our canning laboratory is well equiped for carrying on research work of this character, while the U. S.

Bureau of Fisheries has greatly aided us in acquiring sufficient equipment for fish cultural research work. We are, however, much hampered by lack of equipment for freezing and smoking work, and vessels for carrying on dredging, plankton and other work, but hope in time to overcome this.

GOVERNMENT AID TO FISHERIES.

Many people have the impression that our federal Government has done much to foster and upbuild our fisheries, and, while this is true to a certain extent, much of its efforts have been ineffective through the failure of Congress to appreciate the value of this work. Despite the very inadequate support of Congress, the U. S. Bureau of Fisheries has been. and is doing much to aid and foster the industry.

The reverse is the case with Japan. Just as it was the pioneer in fishery education, so it has been the pioneer in the intelligent upbuildng of its fisheries and the expansion of the foreign demand for its prepared products. Many people object to certain phases of this work as carried on by the Japanese, but I have nothing but admiration for the intelligent and immensely effective way they have gone about it, and wish our own people would adopt the majority of their methods, which I think would immensely profit us and place our fisheries in an unassailable position both at home and abroad.

Less than a decade ago the Japanese awoke to the fact that they had at their doors raw fishery products similar to those from which other nations were preparing much liked secondary products, and drawing wealth therefrom. These were principally salmon, cod, sardines, herring, mackerel, tunny, trout, crabs, shrimp and prawns, oysters and clams. A public sentiment on the subject was soon aroused and a number of firms and companies engaged in the business of preparing such, mainly by canning, and endeavored to dispose of them abroad, the purchasing power of the Japanese people not permitting them to become much of a consuming factor in connection with such high cost products. Very much to the packers' and government's surprise, the foreign consumer almost uniformly refused to accept the products with the result that the packers suffered large losses.

Did the Japanese tamely throw up the game at this stage? Far from it. With their usual astuteness they studied the matter pro and con and finally came to the conclusion that their methods of preparation had not sufficiently taken into account the great progress which had been made in canning methods in other countries, nor the likes

and dislikes of the consuming public in different countries. When they had well digested this, they decided to begin at the bottom and work up, instead of as before, beginning at the top and working down.

They began first with crabs. Trained men from the Imperial Fisheries Institute were sent abroad by the federal government to study methods. These men, without any blare of trumpets, (in fact but few people knew who they were) went into plants as common workmen and watched the various stages of preparation until they had mastered the art. They then returned home and taught the commercial canners. These, fortified with this expert knowledge, installed modern canning machinery, and were soon turning out a product which drove our domestic canned crab almost completely from the Pacific Coast market. At the same time they were improving the product, and very materially improving the container by perfecting one of the best lacquers known for the coating of the inside of the cans used and thus preventing the product from blackening through contact with the metal base should the tin be accidentally cracked or scratched.

After they had established their crab market they began experimenting with sardines, but here they met with very little success, although the last few years have shown an improvement in the demand from abroad. The same has also been true with respect to the mackerel canning and pickling.

During the last 6 years they have been devoting their attention to the development of foreign markets for salmon and cod. Modern sanitary plants have been erected in Siberia for canning salmon, in some of which American experts are employed, and the product prepared compares favorably with that produced on this coast.

With cod the work has been more difficult. The first lots of dried cod were far from attractive and they met with almost uniform condemnation. Again the experts who had been trained at the Institute were requisitioned, and one by one, they visited the various codfish producing sections of the world and studied at first hand the different processes, thence going to the consuming markets and studying their likes and dislikes. Many of these experts have called upon me upon arrival in this country, and I have always found them earnest and indefatigable workers, trained to observe everything and ready to turn their hands to any kind of work, no matter how laborious and disagreeable, only so they could advance their knowledge of the subject. Some of them have been kind enough to remember me with post cards and letters throughout their travels, and it has been

surprising how much ground they have covered and the length of time devoted to the work. One of them went to Alaska, thence to Puget Sound where he worked in one of the home codfish stations where the fish were prepared for market; then to Gloucester, Mass; thence to Norway, from which country he expected to sail for home, his work having occupied two years' time.

And what has our government done in the meantime to improve our methods of preparation and to find an export market for our fishery products?

As to the first, it extended a little aid during the stress of war in teaching those Alaska herring packers who wanted to pack Scotch cure, and also did a little experimental canning work at San Pedro, California, but all this has now been abandoned for economy sake.

As to the second, but little has been done to aid our exporters. A few persons have been sent abroad at times to look up certain fishery matters. One, possibly two, investigations were made which really produced results, but with the exception of these the rest were barren of results.

If we are ever to greatly diversify our canned fishery pack, it will be necessary for the federal government to come actively to the aid of the packers in finding markets, both domestic and foreign. The great increase in our wealth which would result ought to be ample justification for the government's undertaking the work.

In this matter, we should take a leaf from the Japanese book and send abroad properly trained men who know what they are after and are able to understand preparation methods when they see them and who are also fitted to follow the products clear up to the consumers, if necessary, in order to see if these cannot be rendered even more attractive to them.

Another way in which the government could aid our fishermen and fish preparators, would be by a judicious system of loans covering a long period of time and at a reasonable rate of interest. The government has gone into the farm-loan business on a large scale, and there are, in my opinion, no reasons why the same kind of assistance can not be extended to the people who develop our fisheries, or who desire to do so, but lack the money necessary.

A REPORT OF PROGRESS ON THE STUDY OF TROUT DISEASES.

By Emmeline Moore,
N. Y. State Conservation Commission.

This progress report carries forward the studies that were begun last year and reported upon before the American Fisheries Society in a paper entitled "Giardiasis of Trout." It happens that the organism producing the disease is not *Giardia,* but *Octomitus,* a near relative whose full name, *Octomitus salmonis,* has been duly entered in the annals of the society. Its name has been changed to satisfy taxonomic requirements. Its habits, however, remain as verminous as before.

Following the reading of my paper last year on the presence of *Octomitus* in the New York State hatcheries, it transpired that Dr. Davis, Pathologist of the U. S. Bureau of Fisheries, was studying the organism, also, in the Virginia and Tennessee hatcheries. Information has come recently of its presence at hatcheries in three other states—Iowa, New Jersey and Massachusetts. Such spottiness may be interpreted to mean a much more general distribution in the hatcheries of the eastern states, where its recognition awaits only greater discriminatory power in determining the reasons for mortality, now often generously charged off as "normal loss."

Before proceeding with my later findings, let me recall briefly for the sake of orientation the more important features of last year's report.

It was found that *Octomitus* is a minute, protozoan parasite in the intestine of trout, that it is common under hatchery conditions, and that it is the cause of serious epidemics accompanied by high mortality. It was found, also, that all species of trout are susceptible to the disease, the susceptibility of brook trout over other species being pronounced.

The most significant and important information proceeding from the studies last year, and this refers both to Dr. Davis' work and my own, bears on the explanation of the *mechanism of the disease.* It is now known with a fair degree of certainty what makes the fish die, and knowing this neither time nor money need be wasted in doctoring symptoms.

In advancing to the report of progress I must beg your indulgence in presenting unfinished work. It may not be encouraging to point out that perhaps a not less difficult or-

ganism, the malarial parasite, challenged the best efforts of Laveran, Ross, Grassi and others during a period of twenty years before the facts associated with malaria were understood, and the simple remedy of a dose of quinine could be prescribed at the appropriate interval after a chill. When pressed to speed up results in the study of *Octomitus* for their quicker application to practical fish culture, a cheerful reference to this fascinating bit of history proves an effective anodyne in allaying a natural impatience for results. So I beg your indulgence.

In the further study of *Octomitus* the efforts of the Commission have been directed this current year to the following phases of the problem:

1. The examination of wild brook trout waters to determine whether the organism is indigenous to our native brook trout.

2. The examination of wild waters flowing from infected hatcheries to determine the seriousness of infection in the wild state.

3. To continue the life history studies of the organism, including an investigation of the possibility of transmission of the organism through the eggs of "carrier" brood fish.

The question—Is the germ, *Octomitus,* indigenous to our native brook trout?—is not easy to solve. I do not claim to have solved it yet, I am merely attacking the problem. One mode of approach has been by the study of wild waters which for a long period of years have contained only brook trout. Two such waters within the boundaries of New York State have been located and studied this summer. They offer exceptional advantages for the pursuit of this question for the following reasons:

(a) The lakes orginally stocked with native brook trout have been isolated from other fisheries waters for a long period of years. Natural dams, which in later years have been raised somewhat, have kept out fish of various species inhabiting the waters below, particularly the brown trout, which have been introduced into the region in more recent years.

(b) The lakes have been practically self-sustaining. There appears to be one record only of the introduction of "new blood" in these waters and this occured in both lakes about ten years ago. To one lake there was a shipment made of eyed eggs from a Pennsylvania brook trout hatchery and to the other, eggs from a New Hampshire trout hatchery.

(c) A small hatchery exists on each lake whereby the natural increment of increase has been augmented by hatching a certain number of eggs each year from the lake spawners and planting them back in the lake as fry or fingerlings. In this connection the hatchery itself, with its necessarily arti-

ficial features, would seem to supply the essential conditions for the maintenance of the organism were it indigenous in the trout of the lake.

The net result in the search for *Octomitus* among the brook trout of these waters in the hatcheries and in the lakes has been negative. Added to this negative evidence is the positive evidence of our infected hatcheries, where the brook trout are the most susceptible of all trout species, their susceptibility distinctly limiting the period under which they can be carried successfully. This very susceptibility yields strong evidence that the organism is not indigenous when we reason by analogy from the manner in which many of our native plants and animals, unimmunized to the disease germs introduced from abroad, succumb to their ravages.

The possibilities for determining the indigenous or non-indigenous character of the germ are by no means exhausted and to this extent the problem further presents an interesting subject for speculation. If not indigenous, how did the organism get here? Was it introduced into our brook trout waters by way of the Brown or Loch Leven trout from Europe? The inference is strong that it has been introduced in this manner.

The history of the organism bears strongly on the point. Last year Dr. Davis, of the U. S. Bureau of Fisheries, and I, working at different hatcheries, simultaneously recognized *Octomitus* as the infecting organism responsible for epidemics of enteritis at the respective hatcheries under observation. Hitherto this organism had not been observed or described in this country. In Europe, however, this, or a similar organism, has been known for twenty years. In 1903 Moroff described it as the inciting cause of disease among the introduced rainbows of their hatcheries, and he makes the interesting observation that the browns are less affected. This is just what might be expected to happen to the non-immunized rainbows by contrast with the more hardened native browns. In 1920 Schmidt re-described Moroff's organism, which for nearly twenty years had been masquerading under the name of *Urophagus intestinalis*, and rechristened it *Octomitus intestinalis truttae*. I have strong suspicions that this and our own species, *Octomitus salmonis* are identical, and that our species was introduced and has now become a naturalized citizen.

The infection by *Octomitus* of wild waters flowing from hatcheries in which octomitiasis exists seems inevitable under the circumstances, for infectious material is constantly being discharged by diseased fish into the waste waters which enter the streams. As is usual in such streams there are numerous fish which come up to the hatchery outfalls for stray morsels

of food and they afford excellent material for observing how serious the infection may be when they are free to range over wild waters, where natural food is available.

In these situations the adult brown trout and fingerlings carry the organism in varying degrees of intensity, seemingly quite unaffected by it. It is a question, however, how long they can tolerate such severe infections as have been observed without becoming so devitalized as to succumb either to this or some other disease. In the stream where the browns were most heavily parasitized no brook trout were found and the local comment is that they are now never found there. Of course the explanation of their extermination from the stream they once inhabited may lie along one or more lines, either they die of the disease or they are driven out by the browns and rainbows which now populate the stream. Probably both factors operate in their extermination. Infected brook trout,

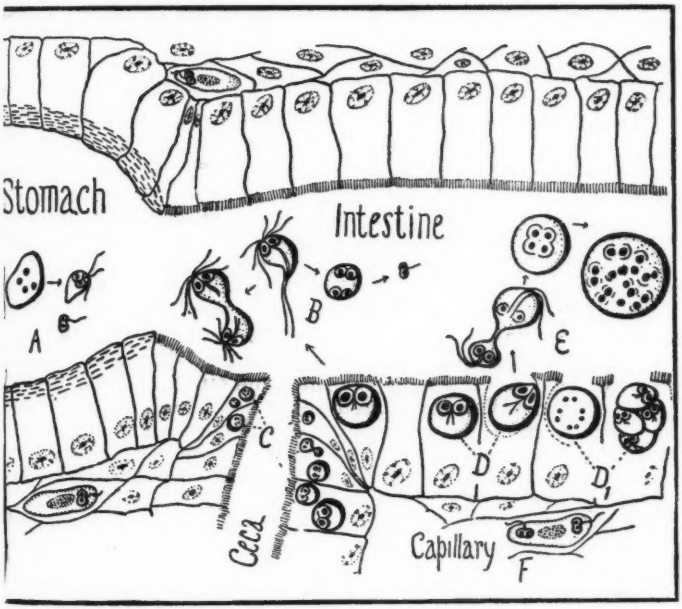


Fig. 1.—Diagram illustrating a section of the digestive tract of trout in typical infection by *Octomitus salmonis*. The organism in its various stages appears in heavy lines in Groups A-F. Group A, segment of germinating spore and juveniles; Group B, a cut with indication, by arrows, of binary division and of developmental stages of growth within the epithelial cells of ceca and fore-intestine. D_1 indicating multiple fission; Group E, stages concerned in the development of a resistant spore; Group F, juveniles attached to a blood corpuscle.

aged two to three years, in waters more distantly removed from hatchery discharges have been found to be "carriers" of the organism, though, at the time of observation, apparently quite unaffected by it.

It is reasonable to suppose that immunity is relatively high in wild waters compared with that under hatchery conditions, where recurring waves of the disease have been observed after the peak of the epidemic is passed, and where its reappearance occurs among two-year-olds that have successfully passed through the first attacks. But it is certain that before any broad generalization can be made on the degree of resistance that infected trout may acquire to *Octomitus* after planting in wild waters more extensive study of the problem is necessary.

In passing to the discussion of the third and last subject, the life history of the organism, I shall make use of the accompanying charts (Figs. 1 and 2), which illustrate in the one case, the *mechanism of the disease*, and in the other, the more formal representation of the *life cycle* so far as it is known.

THE MECHANISM OF THE DISEASE.

By reference to the chart (Fig. 1) it is seen that the seat of infection where fatal lesions are produced lies in the fore-intestine. Here the epithelial or lining cells of ceca and intestine (C, D and D_1) are shown harboring the parasite in various stages of development, from exceedingly minute juveniles less than a micron in diameter to those of 9-12 microns in diameter, ready for emergence from the cells as typical flagellated adults. The time interval required to pass through the intracellular stages is undoubtedly brief, for during an epidemic the fatal lesions develop rapidly. From the intracellular stage the parasites pass into the adult form emerging into the lumen of the intestine on the dissolution or disintegration of the parasitized cell. It can be imagined from the diagram, which for purposes of clearness illustrates only a mild infection, that the drain on the parasitized tissue must be very great when the number of encysted organisms is excessively high.

As indicated, the stomach, fore-intestine, ceca and blood seem to be involved in the cycle of development. The occurrence of the organism in the blood indicates the possibility of egg infection from brood fish that are "carriers."

Juveniles (A) are presumably set free in the stomach on ingestion and germination of a spore, the resistant structure concerned in the transmission of the organism. The mode of progress from this point to encystment in the epithelial cells of the fore-intestinal region is not yet clearly established though the observation that the blood corpuscles seem to be

carriers of the organism suggests their entry through the stomach wall, thence into the blood stream, and finally into the epithelial cells, where developmental stages resulting in the disorganization of tissue take place.

The motile adults whose habitat is the lumen of the intestine move about in the mucous discharges of the epithelial cells. They may be found at any point along the intestinal

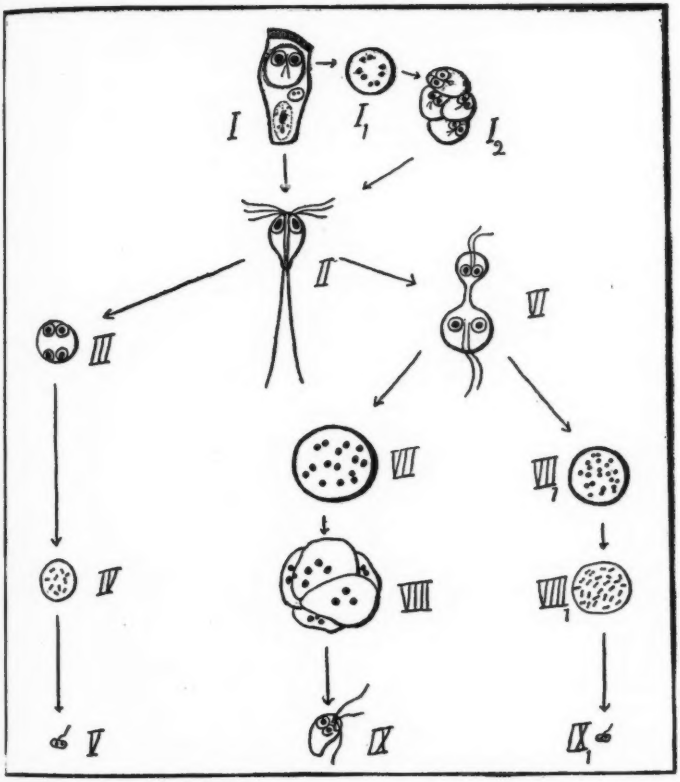


Fig. 2.—The life cycle of *Octomitus salmonis.* I represents an epithelial cell parasitized by two organisms, a juvenile and a later stage before the emergence of an adult. I-II_2, side chain showing multiple fission. II, adult motile form common in the lumen of the intestine. III, an encysted adult within the lumen of the intestine, the 4-nucleate stage of a temporary spore. IV, a more advanced stage of III. V, a juvenile (merozoite), obtained from culture material by inoculation with adults. Stages I-V, asexual cycle which may be repeated many times within the host fish. VI, binary fission simulating budding, a stage initiating development of a resting spore with a hard, resistant wall. VII and VII_1, two types of resting spores. VIII and $VIII_1$, germination stages of resting spores, produced in cultures. IX and IX_1, sporozoites (?), produced in cultures.

tract, though they are generally most numerous near the seat of infection in the fore-intestinal region. While the adults are thus swimming about transformations take place in the various ways illustrated in the diagram, with the resultant production of structures concerned in the further spread of infection. Multiplication (B) occurs by binary fission, the division of one individual into two, and by another more prolific means, schizogony, the intervening structure in this case being a spore or cyst of temporary nature which functions apparently in the spread of local infection.

The development of another type of spore, also a multinucleated structure (E), appears to follow binary fission. Such a spore possesses a hard resistant wall, passes to the exterior in the feces and functions in the transmission of the parasite from fish to fish. It is the structure which doubtless accounts for the presence of juveniles in the stomach in the initiation of new infection.

THE LIFE CYCLE.

By assembling the important stages in the life history of *Octomitus* in their natural sequence of development (Fig. 2), it is possible to show more directly how the organism is equipped for self perpetuation. Starting the cycle with an infected epithelial cell (1), encystment stages carry forward the development from minute juvenile stages to the adult stage (II), by a route in all probability involving schizogony and supplemented by steps shown in the side chain I, I_1, I_2-II).

Dr. Davis* has made a distinct contribution to our understanding of the life history of *Octomitus* by pointing out intracellular development and indicating methods of increase of the organism in the intracellular stages. These findings are corroborated by the writer's studies, though exception is taken to the interpretation of structural features concerned in certain of the developmental stages. For example, Dr. Davis postulates a development of transitional stages whereby binucleated individuals (adults) arise from uninucleated structures (juveniles). The writer's study of culture material in which exceedingly minute juveniles have been observed indicate that the organism throughout its life history is binucleated.

Passing from the adult (II), which is the final product of encystment, two lines of development seem indicated within the intestinal tract, one involving the series of steps included in II-V, suggesting possibilities of increase by schizogony from a temporary spore (III), and the other proceeding from the division of an adult by binary fission (VI) eventuating in

*Davis, H. S. Observations on an intestinal flagellate of trout. Journ. of Parasitology, 9: 153-160, 1923.

the production of resistant spores (VII and VII_1). Such spores as indicated above pass from the intestinal tract and function in the transmission of the organism from fish to fish. The final products resulting from the germination of the spores (VIII, IX and $VIII_1$, IX_1), presumably in the stomach of the new host, carry the cycle to the point of beginning.

To summarize briefly the observations of the year incline to the belief:

1. That the organism, *Octomitus*, is not indigenous to our native brook trout, but was introduced from Europe.
2. That infection extends to wild waters.
3. That the main features in the life history of the organism indicate a complete cycle of events within the body of the fish, with transmission of the germ from fish to fish by means of a resistant spore.

Discussion.

PRESIDENT LEACH: Dr. Moore has dealt very ably with the studies in progress. Octomitiasis is a disease which has also given the Bureau of Fisheries no little concern, and Dr. Davis, our pathologist, has also made some interesting studies in this connection. I am sure that many of you will wish to take part in the discussion.

DR. OSBURN: I wish to congratulate Dr. Moore upon her presentation of this valuable paper and to commend her for the persistence with which she has carried out this very detailed work. An infinite amount of patience is necessary to the pursuance of studies of this kind. One point upon which I am not quite clear is just what is the cause of death? Is there any loss of blood from these lesions, or is death due to toxic action of some sort?

DR. MOORE: There is loss of blood. In severe infection the epithelial cells slough off and this must permit a more or less continuous loss of blood from capillaries that are situated near them. Extrusions of intestinal content show the presence of blood corpuscles, in greater or lesser amounts varying with the severity of the disease, and I think it is safe to say that this is an attending cause of death.

DR. OSBURN: How long does this condition last?

DR. MOORE: It appears to vary considerably. At some hatcheries the disease manifests epidemic conditions early in the season, at others later. An epidemic during which practically all fish become infected may be in progress several weeks.

DR. OSBURN: It might be a wasting disease as a result of loss of blood might it not?

DR. MOORE: Mortality is highest among the stunted and emaciated fingerlings and there is every reason to suppose they have had the disease longest. They have large heads and thin wiry bodies, they carry heavy infections of the organism and have been observed to take little or no food.

DR. OSBURN: Might death be due to interference with digestion? If there is a diseased area covering a large portion of the intestinal tract, the result would be a lack of the absorption of food. But, if there were any intense toxic effect, you would expect that death would come sooner.

DR. MOORE: From the nature of the excretory products I should say there must be more or less chronic indigestion. As to toxic effects operating in more rapid cause of death, I am unable to judge except by inference. Some diseased fish, less emaciated than others succumb to the disease quickly, the reason therefor may be a toxic effect due to a condition favoring an excessively rapid production of the organisms.

DR. OSBURN: How much of the intestine is affected? What portions of the intestinal area might be sloughed off in the severer cases?

DR. MOORE: The seat of infection is in the fore-intestine and ceca. Other portions of the intestine are invaded by adults, but I am not yet sure that the epithelial cells there are parasitized. Dr. Davis' findings indicate that the parasitized tissue occurs only in the ceca and fore-intestine. These seem to be the portions that easily slough away. It is possible that there may be invasion of epithelial cells lower down in the intestine in the severer cases of infection of larger fish.

MR. TITCOMB: May I inquire whether the eggs of the fish carry the organism?

DR. MOORE: That seems a possibility from the fact that the organism is carried in the blood.

MR. TITCOMB: It would be necessary to establish that if you are to attribute the importation of the disease to the brown trout.

DR. MOORE: Yes. I realize that, and that it will require much time and exhaustive study and experimentation to establish the fact one way or another.

MR. TITCOMB: It would mean all those states which are buying eggs from infected commercial hatcheries are liable to introduce the disease.

DR. MOORE: The disease is certainly very infectious and probably no state in the East is free from it.

MR. TITCOMB: The disappearance of the brook trout has in certain cases been attributed to cannibalism of the brown trout. Do you think that part of that disappearance of brook trout may be attributed to this disease?

DR. MOORE: It seems reasonable to think so, especially as our knowledge of the feeding habits of the brown trout become better known. It seems from the observation that the brown trout is more of a bottom feeder than the brook trout.

MR. TITCOMB: You have not found anything new in the way of a remedy, or anything in the diet to regulate it.

DR. MOORE: No. More perfect sterilization measures seem the only hope at present. As to regulating the diet, I have not given any attention to that side of the problem. I understand that Dr. Davis of the U. S. Bureau has been investigating that phase of the subject.

MR. HARE: Is there any connection at all between octomitiasis and gill trouble? At the Manchester station the brook trout have for years had an infection of the gills, and it seems they have never been able to solve that problem. Under the glass they show no parasitic growth whatever. I am just wondering whether *Octomitus* would cause that trouble at Manchester.

DR. MOORE: Since I have found the organism in the blood it has seemed possible that various parts of the fish should show pathologic conditions. Before my attention came to be drawn to the study of octomitiasis at the Bath hatchery, where no doubt it had been endemic for years, the mortality had been ascribed to "gill trouble," because as death ensued the fish seemed to exhibit symptoms of suffocation. It has seemed to me that the gill symptom was due rather to mechanical causes. As the fish become less active during the progress of the disease various matters passing through the troughs in the water—algae debris, food particles, etc.—may easily clog the gills and cause the feverish action so noticeable. There is room for further study of this phase of the question. Fish afflicted with octomitiasis will, under certain conditions, develop a red spot or congested area of the blood noticeable beneath the skin, on the fin or the belly, in the eye and other parts. Very minute congested areas are also found in the gill tissue. These seem to be manifestations of the disease.

MR. TITCOMB: The so-called red spot disease, which has occurred at Long Island, is not attributable to *Octomitus?*

DR. MOORE: The red spot which occured at Long Island in 1898 and 1904 is not the red spot to which I have referred. The Long Island trouble was associated with an open sore and was similar to furunculosis.

MR. FEARNOW: As I understand it, the disease was introduced from the brown trout. The brown trout is what we might term a more highly cultivated fish than the brook trout or rainbow trout. Is it not possible that this disease is one of the effects of a high degree of civilization in fishes?

DR. MOORE: It seems probable, in the light of observation and history that the disease has been introduced. I think really the brook trout culture antedates brown trout culture.

MR. FEARNOW: Is there any preventive for this disease, or any known method of treatment?

DR. MOORE: The only preventive that seems at all practicable at present is a careful regard for prophylactic measures. In an infectious disease of this kind, thorough sterilization methods are certainly necessary in keeping the disease under control. Attention must be given to certain details, such as the avoidance of the use of utensils, brushes, feathers etc., the second season, since they may harbor the resistant spores.

MR. TITCOMB: Would it be advisable, in the case of fingerlings at any given plant, to divide that plant into sections and use separate brushes for each lot of progeny reared through the season?

DR. MOORE: Yes. And a brush for every trough is even better. This routine is very hard to establish as we find and as you will find, no doubt. When the hatchery laborer has learned the various mechanical operations and works efficiently and swiftly in cleansing one trough after another keeping the same brush in hand, it is hard to divert him from that routine. Even though you bring him to the microscope and show him the organisms in all their stages and indicate how infectious they are, it is difficult to impress upon him the greater need of thorough sterilization methods. Everything that helps to reduce the spread of infection must be resorted to in keeping the disease in check. The use of separate utensils and frequently scalding them must in the long run be efficacious. Heat kills readily most pathologic organisms of the fish. A fortunate circumstance, since otherwise we should not enjoy fish in our diet as much as we do.

MR. ADAMS: For the purposes of record, that the men in our hatcheries, that is, the young fish culturists, can get it, will you describe briefly the exterior appearances or symptoms of octomitiasis?

DR. MOORE: I have been thinking a good deal about how "to put it over" to our hatchery men that they may recognize the disease and deal with it early. Briefly the symptoms may be described as follows: as observed in the troughs, badly infected fingerlings have a characteristic behavior. Balance seems easily lost and they flop from side to side, or roll over repeatedly with a "whirling" or "corkscrew" motion. They appear to "bore" into the water. Just before death they lie on their back with gills distended and in feverish action. Those greatly weakened by disease and dwarfish in size congregate in the corners at the lower end of the trough, or nose along the sides, keeping near the surface. The fish usually die on the screen or nearby at the foot of the trough. Sick fish removed from the water will give more specific diarrhœal symptoms and pass a yellowish, watery fluid on the slightest pressure. In the troughs the superabundance of excrement in partial stages of digestion is noticeable also. Of course in other diseases afflicted fish may turn on their backs and have difficulty in breathing; that is, they may show a similar "gill trouble" and emaciated ones may congregate in the corners, but, if all the symptoms taken as a whole appear, it is a pretty sure indication that octomitiasis is present. The symptoms of a disease in which lesions occur internally should be supplemented by microscopic examination.

MR. ADAMS: Are there no external marks on the fish?

DR. MOORE: Generally there are not. I strongly suspect, however, that the red spotting I have previously described as due to a congestion of the blood beneath the skin is an occasional manifestation of the disease.

MR. ADAMS: Side by side with that explanation, will you briefly put into record a description of furunculosis?

DR. MOORE: In the literature we find furunculosis described by the German pathologists as an infectious disease of adult and yearling trout.

The first signs are most apparent internally in an extensive inflammation of the intestine and peritoneum. Sometimes the symptoms of enteritis are lacking and the second, or ulceration stage, manifests itself directly. As described in typical furunculosis, hemorrhagic spots appear in the deep or shallow portions of the muscle. These spots quickly develop into sores which eventually break through the overlying flesh. The skin gradually bulges out, producing "furuncles" or swellings varying from the size of a pea to the size of a nut. The inside of the sore contains a purulent mass of muscle fibres, pus and bacteria. On perforation of the sores flat ulcers appear; some of them deep and not larger than a five cent piece. A foul colored, bloody mucous flows from them, but generally this is washed away by the movements of the fish in the water and the spots appear less bloody. The later German authorities indicate that the ulcer or sore is a manifestation which may or may not be present in furunculosis.

The course of the disease is usually short, death occurring in two to three weeks after infection. In the earlier writings the authorities indicated that the disease is most likely to occur where there is putrefaction in the bottom of the pond and in the water, especially when in the course of artificial feeding remains of food in excess foul the bottom. But later, as observations were extended to wild waters, it was found that pollution did not enter into the question. It was found that in wild waters infection does not follow so suddenly, nor so severely as under artificial conditions and the disease may last longer, including a period of several weeks or several months. It was found that a bacterium (*B. salmonicida*) was the inciting cause of the disease and produced a very general infection, spreading throughout the body, in the blood, liver, kidneys and muscles.

Certain manifestations of the "ulcer disease," as described by Calkins and Marsh during epidemics at Cold Spring, L. I., show a striking similarity to furunculosis. The difference between the two diseases lies apparently in the origin of the ulcer. According to the German authorities furunculosis is caused by a bacterium; according to Marsh the ulcer disease is not but belongs to the type "whose living causative agents are not to be cultivated outside the body by the usual methods." The ulcer, as described by Marsh, is of the rodent type. It starts as a spot on the skin and erodes on all sides, progressing just beneath the skin, leaving overhanging edges or flaps of loose skin. In furunculosis the ulcer penetrates the flesh. The ulcers described by Calkins may be shallow or deep, and it seems quite probable that the disease we have in this country is a manifestation of furunculosis.

MR. ADAMS: Do you believe that furunculosis can be transmitted through the egg, as is probable with the disease you have been discussing this morning?

DR. MOORE: It is possible that the disease is transmitted through the egg. We know little as yet of egg infection, but by analogy with

what happens in chicks, where it is known that the disease "bacillary white diarrhœa of chicks" is so transmitted, it seems highly probable.

MR. ADAMS: The reason I ask that question is that our brood stock at our fish hatchery at East Sandwich, consisting of about 25,000 fish, was absolutely wiped out three years ago by what our biologists identified as furunculosis. We practically abandoned a portion of the hatchery for a year, and we carried out the sterilizing and prophylactic measures which you have described. Despite our efforts we have reason to believe that the same disease has appeared at a couple of our rearing stations this year. We know of no way to account for the communication of the disease unless it was through the egg, for no small fish have been sent from this hatchery to the rearing stations.

DR. MOORE: Do you think that a bird could have been the carrier?

MR. ADAMS: It is barely possible, because we have the usual running fight with the kingfisher and the blackcrowned night-heron, and even with the catbird and the robin.

DR. MOORE: The question comes to me, because two lakes in the Catskills quite isolated from each other have been infected. There had never been any contact between the two lakes so far as the transfer of either eggs or fish is concerned. It looks in that case as if a bird might be the transferring medium.

MR. ADAMS: In regard to *Octomitus*, how long will the shell of the spore remain intact in open water and remain sufficiently vital to germinate when, subsequent to its being deposited in a stream, it finds lodgment in the proper chamber of a fish to undergo further development?

DR. MOORE: I cannot answer directly from my own experience. Dr. Schmidt, in his work in Bavaria found that the spore was very resistant to drying and to heat. His experiments extended over an interval of several days. It is quite possible that the spore can retain its vitality in water for weeks or even months and resist an equal period or longer of drought.

MR. ADAMS: If this disease is found prevailing in a hatchery, would you advise the liberation of the fish on the theory that upon being restored to the wild state they may cure themselves?

DR. MOORE: I believe they do not entirely cure themselves. The infecting organism must perpetuate itself and on this account it would be impossible to believe that the fish, when introduced into wild waters, would be rid entirely of the germ. The fish are doubtless much helped by their more extensive range over wild waters and by securing their natural food, and to this extent improvement could be looked for. There is always the possibility however of infection being spread by the carriers.

MR. ADAMS: Would a change in the temperature of the water; that is, a rise in temperature, retard or speed up the disease?

DR. MOORE: It would tend to speed up the disease judging by the influence of increasing temperature on cultures of the organism.

MR. HARE: I gather that these parasites are so minute that approximately four million of them could be placed on a twenty-five cent piece. That being the case, I doubt whether we could recognize the parasite even with the use of the glasses that we have at the stations.

DR. MOORE: In the days when I made my rounds of some of the Federal hatcheries I recall that we had quite a number of small microscopes ordered, particularly to study foods. They would be inadequate for the study of such organisms as these, whose size individually is approximately ten 25 thousandths of an inch. A lens which will magnify seventy-five times, i.e. a number sixteen objective on the compound microscope, would enable you to recognize the organism. With that magnification you would be able to distinguish minute, clear watery, pear shaped objects darting about. A higher magnification, a 4 mm. objective, magnifying 900 times, would enable you to see a quite remarkable beast equipped with the characterictic number of flagella at the anterior and posterior ends and with a facility for using them which is quite astonishing.

MR. WEBSTER: Do you attribute fin disease to *Octomitus?*

DR. MOORE: I do not. One type of fin trouble is caused by a bacterium, another by a flat worm. I have observed that the fin trouble may be present together with octomitiasis. The causative agent in each case is a specific organism.

MR. TITCOMB: That latter fin disease, Gyrodactyliasis, is very probably due to filth, is it not?

DR. MOORE: Possibly, it would be in some cases.

MR. TITCOMB: With regard to the two Catskill lakes to which you referred, perhaps the disease was introduced through artificial stock.

DR. MOORE: Artificial stocking took place only once in the history of those lakes. It is extremely difficult to trace back to their beginnings the causes and results of our complicated stocking policies.

DR. OSBURN: I understood you to say that certain of these fishes appeared to be more resistant than others and the question at once occurred to me whether it might not be possible eventually to breed from a more resistant strain as plant breeders and animal breeders have been able to do, and so eliminate the disease, or at least eliminate the effects of the disease, in that way. If that is the case it seems to me that the practical thing for trout breeders to do is to get that resistant stock and make a serious and continued effort to breed from that sort of strain rather than take any type of wild trout that certainly will become infected in the course of a few years. Trout eggs are being distributed throughout the country in such a way that, if there is any possibility of the disease being carried in the eggs, I see no way to prevent it from spreading everywhere as various other diseases and pests have done. If we could get under way a good resistant strain from which we could supply hatcheries, it would only be a short time when trout bred from that strain could be supplied everywhere and, even if we could not eliminate the disease, we could largely eliminate its effects.

MR. FOSTER: An interesting case came up at Neosho last spring when Dr. Davis was there. He had just returned from Manchester station after examining the effects of *Octomitus*. Hardly a year previously we had received some yearling brook trout from the Manchester station which no doubt had the disease at the time they were brought to Neosho. These were examined by Dr. Davis as were other trout at Neosho, and no trace of *Octomitus* was found. What the condition was that eliminated it we do not know.

One of the symptoms mentioned by Dr. Moore, the heading of the fish to the side of the trough, is also a symptom of disintegration of the kidneys with crystals, which condition we have had to deal with for a couple of years. The crystals are very prominent and the disintegration is quite noticeable. That can be corrected, as has been found in some hatcheries, I believe, by thinning the fish from the troughs at an early age and placing them out of doors. We found that by doing that the trouble did not occur, whereas we did have it where the fish were held in the house.

It would seem that there is some similarity between octomitiasis and intestinal trouble in the human being in connection with which the typhoid serum is administered, so that the measures employed in the treatment of typhoid might apply in some degree to the treatment of *Octomitus*. Of course, we can scarcely develop a serum for the treatment of each individual fish, but some of the measures adopted might be of use.

DR. MOORE: That is an important observation regarding the elimination of *Octomitus* from presumably infected trout and is paralleled more or less by a single observation of my own. Not long ago I visited one of our hatcheries where in recent years it has been impossible to carry adult brook trout very long in the ponds at the station. One adult male brook trout, about 12 inches long survived. On examination it was found not to be infected with *Octomitus* but by another species of protozoan parasite, a sporidian. Such observations, however, must be greatly extended in order to generalize from them the conditions favoring immunity.

The point raised by Dr. Osburn regarding the development of immune strains seems a most practical and forward looking suggestion. Dr. Embody has already started work along this line. From my observations at the Bath hatchery the trout fingerlings which survive do so because they apparently acquire immunity. After the epidemic passes the survivors attain a splendid growth and become remarkably fine fish for planting. They are however "carriers" still. What happens after planting in general is still a matter of conjecture. Some specific instances of what happens near hatchery outfalls have been discussed in my paper.

MR. BULLOCK: When our scientists took up the study of the cause of malaria and found the organism, they not only recommended prophylactic measures, but they found a medicine which was effica-

cious in the treatment of the disease. When they took up the question of the hookworm in the south, again they not only found the organism in the intestinal tract and recommended sanitary measures, but they also prescribed a medicine suited to the case. Now, have you scientists done anything along the line of adding medicines to the food of the fishes and noticing their effect on any of the organisms? Of course, the first thing the fish culturist resorts to at the fish hatchery is salt; that is his panacea for all ills. But has anything else been found which would meet the case? Should we stop with locating the organism? Could not medicine be administered with the food?

DR. MOORE: Nothing of moment has been done yet in the matter of interior medication. The use of salt, which has been regarded by fish culturists as a panacea for everything, has been vastly over-estimated and is of no special value in octomitiasis. The administration of medicine to fish that are an inch long, for that is about the size of the earliest casualities, is a difficult and an uncertain proposition, even though it could be administrated with the food. The possibilities of over-doses and under doses, when so administered is a matter to ponder over.

MR. BULLOCK: If it should be true that the organism is transmitted through the egg, let us cure it in the adult fish and get good eggs; then by employing the prophylactic measures, from the spring on down through the hatchery, we have conquered the trouble, have we not?

DR. MOORE: We have, optimistically speaking.

MR. HAYFORD: One of our commissioners, when he sends me to these meetings, always asks whether Dr. Moore is going to be there. The last time he said: "I have read Dr. Moore's paper in the last Transactions and it seems to me what we need is more Dr. Moore." In 1917 we started to compare the rainbow, brown and brook trout in waters that were alike. We were in a position to do that because we have six chains of ten ponds, each running on the same water supply. In the course of our operations we have come in contact with the various things that the average fish culturist runs up against; in fact, I believe we have all his problems. We are not always aware of them, but now and then they break out and wake us up. In 1917 we started to carry our own brood stock. In the case of some of our brook trout we have reached the third generation; in our brown trout the second generation.

Not being a scientific man I am simply going to talk as a practical fish culturist, on the basis of observations I have made. The first trouble we ran into was designated by our scientist as *Bacterium truttae*. We started to study that; we did not eliminate it, but we helped to do it a little bit. The next season we ran up against furunculosis. Neither of these diseases was disturbing to any considerable extent. This year we have both *Octomitus* and *Gyrodactylus*. *Octomitus* was present in the brown and brook trout; of that I am positive. As to the rainbows, I am uncertain. You must understand that I am not an expert microscopist

either, but, when I have been shown a bug, I can recognize him. You cannot mistake *Octomitus* after seeing him once.

We have had some rather interesting experiences in connection with *Bacterium truttae.* We tried changes of food and the benefit has been so great that, on examining the brook trout this year, we found no traces of this organism. Whether relief is only temporary, of course, we do not know. With regard to furunculosis, we had last year about 2000 brown trout breeders in a pond that would run anywhere from 10 to 16 inches long. A warm spell came on and we changed the fish from one pond to another, expecting the water temperature to drop. Instead of that it rose and furunculosis appeared on about one hundred of the fish, whereas in a pond where no change was made the fish exhibited no symptoms of the disease. I believe the way to get at this trouble is based upon three factors, namely: the study of the temperature of the water and its effects, the study of fish foods, and the building up of resistant strains. There are many instances in which a very slight change in temperature has a marked effect. It has been our experience that *Bacterium truttae* is never very bad after the fish attain the age of eight months and there are very few symptoms of furunculosis after they attain the age of 12 or 18 months. In our plant we have at the present time, roughly speaking, 150,000 fish running from 4 to 12 inches long. There are probably only about a hundred fish now afflicted with furunculosis.

Our ponds are so built that we can clean everything out and the oftener we clean the ponds the less trouble we have. Cleanliness helps a great deal in connection with Gyrodactyliasis. It also helps in the case of furunculosis, but I cannot see that it means much so far as Octomitiasis is concerned. The fish culturist needs the scientist to check him up. We have been employing Dr. Embody for the last five or six years. He is much too modest to tell about the things he has observed, but he has certainly been a wonderful help to us. We run our plant in four distinct sections, each having its own water supply, and we have a man who looks after each section. Acting on Dr. Moore's suggestion, we keep the brushes separate; we have determined to do that even if we have to put a tag on the man and on the brush too. We find that it helps a great deal. Another thing that helps is to be able to turn on a big flow of water. The man in charge of these operations says, and I will quote him exactly: "John, turn on a hell of a flow of water."

MR. JOHN P. WOODS: On the assumption that this disease is the result of a foreign invasion, I would like to ask Dr. Moore whence it came?

DR. MOORE: It is impossible to answer positively. The brown trout was introduced into this country from Germany in 1883. My theory is that the disease may have been introduced through the importation of eggs at that time. A hundred thousand brown trout eggs were sent to Mr. Fred Mather, Superintendent of the hatchery at Cold Spring Harbor, L. I., as a present from his friend, Mr. Von Behr, President of the German Fisherei Association. According to the records, some of these eggs

were placed in the Cold Spring hatchery, on Long Island, some in the hatchery at Caledonia, N. Y. and others were presented to the U. S. Bureau of Fisheries, being transferred to Mr. Clark at their Michigan station. Scanning the literature for records of outbreaks of disease both previous and subsequent to the importation of the eggs, I have found very little authentic data to support my theory. Nothing but a devastating epidemic has seemed worth mentioning in the annual reports and these have not always been accompanied by the attending symptoms of the disease. There must have been in the nature of things many lesser epidemics. In this connection a too great modesty has prevailed in mentioning them, perhaps for statistical reasons (laughter), consequently we are deprived of much valuable information that might serve as a basis in arriving at some conclusion as to the effects of these foreign importations of fish eggs.

MR. LEACH: This has been a very interesting paper, because the subject is one of vital importance to everybody interested in trout. I want to give all an opportunity to discuss the matter with Dr. Moore, and, if she is willing to continue, we shall be glad to hear from any others who wish to ask questions or speak on the subject further.

MR. TITCOMB: If you require specimens for examination, are fresh specimens necessary?

DR. MOORE: It is possible to use preserved specimens, but generally the preservative used is the one that is handy and that one is not usually the most desirable for further study of the organism. The most ideal way is to visit the hatchery with a microscope, then a diagnosis is possible, often within a few hours. Fresh specimens in sufficient numbers are the next best thing.

MR. TITCOMB: For the benefit of the laymen in the fish hatcheries absent from this meeting, will you tell us what is the best way of putting up fresh specimens to be shipped for examination?

DR. MOORE: Shipment in cans alive by ordinary shipping methods is the best way. Diagnosis is simplified and in some cases only possible when the fish are sent before death ensues, for the reason that various invading organisms following death, such as bacteria, protozoa and the like, may obscure entirely the correct line of diagnosis. When fish cannot be shipped in cans I have found it useful to have them wrapped separately in a moist cloth, packed in ice, and expressed with dispatch.

MR. BULLOCK: Would shipment in a solution of formaldehyde answer the purpose?

DR. MOORE: Formaldehyde is a useful preservative, but it is used indifferently at various concentrations. I do not know, however, of anything better for general purposes.

MR. DOZE: The brown trout have been introduced in the higher altitudes. Have you ever received specimens from the Rockies and do you know whether or not this disease is prevalent there?

DR. MOORE: I have not received specimens from that quarter. I think it would be very desirable to get this information and for the

Pacific Coast Fisheries College to examine the rainbows in their native haunts.

MR. DOZE: Is there any indication that *Octomitus* has ever attacked our scale fishes of the warmer waters, including the sunfish, or the catfish?

DR. MOORE: There are no records in this country of its occurrence in any fish except trout. In Europe however, its presence, or that of a similar organism, has been noted in a carp feeding at a hatchery outfall where infection by *Octomitus* was prevalent. It has also been found in the marine fishes, Box and Motella, in the Mediterranean.

DR. EMBODY: Through the kindness of Mr. Hayford and the Fish Commissioners of New Jersey, I was fortunate to have placed at my disposal a number of specimens of trout infested with this particular organism, *Octomitus*. Upon referring to Dr. Moore's paper, we were able to identify it definitely. There was one diagnostic character that I noticed which I should like to mention. It refers to the greatly distended condition of the upper intestine, giving the appearance of a fish that has been greatly overfed. I thought, when I first observed it, that the fish was gorged with food, but, on examination, I found that the intestine was destitute of food, and filled with gas. In nearly all the fish in which we found the intestine distended, there were large numbers of this particular organism. If it proves to be a good diagnostic character, coupled with the other diagnostic characters that have been mentioned, it would be a very good way to tell whether or not the disease occurs naturally. However, the only sure way of recognizing the disease is to examine the intestinal fluid with the microscope. Even then, unless you have had the organism pointed out to you before, it may not be possible to tell whether this is the particular organism that is causing the trouble.

Another point has come to my attention which bears upon the question of how this organism can be carried. Dr. Moore has stated that it exists in the encysted form which is resistant to influences that will destroy other active organisms. If such is the case, would it be necessary for it to exist in the egg of a fish in order that it might be transmitted from one hatchery to another? In connection with our method of dipping eggs out of a tray, dumping them on another tray and surrounding them with moss for shipment, would it not be possible to transfer some of the encysted forms in this way from one hatchery to another? Might not that have been the case in the transportation of the brown trout from Europe to this country?

DR. MOORE: It seems quite probable. Your observation regarding the distended appearance of the intestine due to an accumulation of gas seems to me not altogether trustworthy as a general symptom, though it may be found so locally. Gas accumulations occur apparently in connection with the development of yeasts in the intestine. These I find do accompany the organism *Octomitus* at times in great quantity.

DR. EMBODY: If it is found that this organism has come from Europe, of course, it is nothing more than a repetition of what has taken place heretofore in the case of many kinds of animals and plants. I assume it is not an exaggeration to say that by far the greater number of organisms that are giving trouble in this country now among plants and animals have been imported from Europe. I cite the case of the chestnut bark disease, the Chinese beetle, which has come recently, the corn borer, and many others. If *Octomitus* came in that way, it only repeats history so far as the importation of these things from Europe is concerned. I prefer to think it came from Europe than to believe that it was indigenous to this country.

MR. TITCOMB: It is important to inquire what precautions may be taken when we buy eggs, to have them properly packed and sterilized—if that is the proper method—in order that we may not introduce the disease into hatcheries where it does not now exist. It is eminently desirable, even this fall, that we should take the necessary precautions to guard against the transfer of *Octomitus* externally on the eggs.

DR. MOORE: Precautions should be taken, but, unfortunately, we have not yet made any experiments as to the best method of procedure in guarding against transferring the spore. This as I have indicated, is a very small thing, about 25 microns, more or less, in diameter, or about 1/1000 of an inch.

MR. TITCOMB: The eggs arrive at the hatchery with the same water that has been constantly used in connection with them. Would it be possible, do you think, to wash those eggs before they are packed, perhaps taking the water at its source, thus washing out any of the conveying cysts or spores?

DR. MOORE: That would seem a reasonable precaution to take, but I do not know to what extent the natural stickiness of the outer envelope of the egg would cause the organism to cling to it. These are questions that should come up again and again until we know how to answer them.

MR. BULLER: In your opinion, would furunculosis be carried through the food given to fish? The reason I ask is that some few years ago I got the idea that we could produce a more highly colored trout by feeding shrimp from Louisiana. In the pond in which shrimp were used as food we lost practically every fish. I was wondering whether the disease might have been introduced into that pond in that way.

DR. MOORE: My line of reasoning would be this: Organisms or disease which fish are heir to must invariably be present in greater or lesser numbers in fisheries waters and, if the fish for one reason or another become devitalized, infection might become so severe as to indicate symptoms of disease. It is possible that feeding shrimps alone would induce a lowering of vitality by way of its being an unbalanced ration. Assuming the causative organism of furunculosis is present, it would be only in some such indirect way as this that the shrimp could be a contributing cause. We have, however, no knowledge of the

presence of the causative agent of furunculosis in any marine organisms other than members of the genus Salmo.

PRESIDENT LEACH: Dr. Moore, on behalf of the Society, I wish to thank you for your very interesting paper. It will make a valuable addition to the Transactions of our Fifty-third Annual Meeting, and I am sure both paper and discussion will be read far and wide. I hope that you will continue this work and that at the next meeting you will report upon your further findings.

PIKE-PERCH PROPAGATION IN NORTHERN MINNESOTA.

By Eben W. Cobb.

Northern Minnesota is supplied by nature with the best conditions for pike-perch to be found. Here are the head waters of three great water systems with literally thousands of clear lakes, many of which are of a large size. Much of this territory is wild and will doubtless remain so for a long time.

Pollution except in Rainy River, is a thing unknown and only the acts of man interfere with the fish. Once the supply of pike-perch seemed inexhaustible, but where good roads have been opened and the summer tourists have come in there has been a rapid decrease in the number of fish and in some instances the depletion has been great enough to cause poor fishing. The vicinity of Detroit may be taken as an example. Here is one of the very best lake regions in the state. Within a comparatively short period of time, the pike-perch, which were here in seemingly countless numbers, have been reduced to such an extent, that those whose purpose it is to find pike fishing pass on to other waters.

The taking of pike-perch eggs by our state at one time, was carried on for the purpose of securing eggs, that fry might be furnished to lakes throughout the more thickly settled portions of the state. As it became apparent that the supply of these fish could be maintained only by looking first after the large and productive lakes throughout the northern portions of the state, a definite programme was formed with this object in view. The building of field stations, which were in reality hatcheries, was undertaken. These were located at or near the spawning grounds and in them were placed the eggs as they were taken from day to day. A large part, and in many cases all, of the resulting fry were returned to the waters from which the spawn was secured. In some instances spawn was taken to the other hatcheries. The primary object was to care for the spawn producing lakes but it is interesting to note that the average hatch where eggs were placed in jars without shipment ran about 25% ahead of the hatch where shipment takes place in the green stage. This will be of interest to those studying the causes of losses in pike-perch eggs. We also feel that there is a saving in numbers due to the direct planting but

have nothing definite to offer on this. It can readily be seen that the average cost of the fry was greatly decreased.

At present, we have twelve hatcheries equipped for handling pike-perch eggs. Seven of these are operated during the season for this work only. Last Spring we planted 353,647,000 fry. Nearly all of these hatcheries are in the northern part of the state.

Besides this added propagation work we have succeeded in extending the close season on these fish to May 15th, with a days limit of ten and a limit in possession of twenty fish. The buying or selling is prohibited.

A hatchery was constructed in the Rainy Lake region, and put into readiness for operation in 1922. During that year 89,100,000 eggs were taken and from these 75,075,000 fry were produced. During 1923 eggs to the number of 136,140,000 were secured from which 61, 940,000 fry were produced and 10,000,000 eyed eggs were forwarded to other hatcheries. Besides this 20,000,000 eggs were taken and shipped in a green state.

Though this lake extends for a distance in a direct line east and west for about forty miles and has many bays and inlets we have operated one trap only in Rat Root River. During the last season no attempt was made to take spawn from all the fish coming into the trap and many thousands of spawning fish were allowed to pass above the nets and continue up the river. The percent of hatch was not so good in 1923 as in 1922 due to one large lot of very poor eggs. We did not determine the cause of this condition. There is no reason to believe that many times the number of eggs secured could not have been taken had we been provided with jars to care for them and men and equipment to take them.

The total hatch for the season ran 42% on eggs shipped green and 60% on eggs hatched where taken, which is a little lower than is sometimes the case. The opportunities for this work in Northern Minnesota are almost unlimited and it is only lack of money which prevents the work being increased.

The loss of eggs is one of the most interesting details of the work. My observation leads me to believe that in normal years when temperatures hold right during the spawning season eggs of this species can be fertilized with almost the same degree of success as with trout or salmon. The great delicacy of the egg is our great source of trouble but besides that we often meet conditions which we are absolutely unable to explain. From one of our stations we receive eggs well fertilized and they eye up a good percent-

age. After the eggs are eyed up they begin to adhere to the extent of causing a poor circulation. A slight movement with a feather will start the circulation again but the eggs are so delicate that the loss is considerable and we never secure a good hatch from these eggs though a nice percentage reach the eyed stage. We find that when these eggs are retained in the water, where taken, this condition does not exist. We now hold all the eggs at this collecting station in the hatchery located on the river in which the run of pike takes place. We are unable to advance any reasonable explanation of the condition. It is only one of the many problems not talked about by writers on fish culture.

Penning of fish is another problem capable of making much trouble. We have been told that the welfare of the fish while penned depended upon the circulation of water, amount of oxygen, temperature and the number of fish confined in a given space. We have had occasion to watch this matter closely and fourteen years study has convinced me that while the above conditions must necessarily affect the fish, as they affect all life they are not the condition that cause the most trouble in Minnesota.

In 1910 I spent the entire spawning season on Rainy River. Our main problem was holding the fish. At that time tremendous numbers of large pike could be taken below the rapids at Birchdale and some of them yielded from two to two and one-half quarts of eggs. The average of all fish stripped was about one quart. The water ran extremely high being about fifteen feet above normal summer level.

Above the spawning grounds was a mile of rapids and one mile below our pens were placed. This mile of water was one rushing mass. Under these conditions there could have been no lack of aeration and certainly no lack of water. The temperature during the season was hardly above that required for good spawning condition and sometimes below. I placed the spawners in cribs made from netting and also in pens made from boards. In some instances I closed portions of the pens and left other portions free to circulation so the fish could take their choice of current. I anchored pens in the current and also below the dock. Some were crowded and some were nearly empty. The results were the same in all cases no matter how placed and regardless of numbers. The fish showed signs of sickness the second day. A pinkish color showed on the tail and also, slightly, on the cheek. Another indication which I have not mentioned elsewhere was a slight depression along the center of the belly which seemed to be caused by a shrinking of

the ovaries. Fish could not be held over the end of the second day without loss.

At Tower, which is one of our best stations, we were not penning fish at all but seining, stripping those ripe, and releasing the balance to be handled over again. In 1912 I put in three weeks at this point and put in a trap and holding pens. Conditions of the water were similar to those at Rainy River but on a smaller scale. I was glad to learn, that at this point fish could be held indefinitely and under almost any conditions which could be desired. Loss from penning at Tower has never occurred and none of the signs of sickness have been in evidence.

Other investigations have been carried on in other places and though it will doubtless raise a question of scientific reasoning I have found the following to hold true in every case during my fourteen years service in Minnesota. Where the run is composed of large yellow pike they cannot safely be penned longer than from one day to the next. A run of black pike can be held as long as desired and between these colors the ability to stand penning very closely corresponds to the degree of color. I will not try to explain this but hope some time a scientific study of this subject can be made. Up to this time I believe we have results from scientific reasoning which is altogether a different thing from scientific study.

I do not believe color would have any effect on fishes' ability to stand penning but it does not follow that the conditions which produced the color would not otherwise control the general life of the fish.

One thing has held true in all cases where conditions are such that fish return for the day to some point further down the stream. When they are released below the net the same fish return at dark and will continue to come to the net night after night until ripe apparently suffering no harm. It all leads me to believe that the cause of the trouble is in the nervous system of the fish rather than in the physical surroundings and that the condition which brings this out strongest has a direct bearing on size and color. In any event we have only experienced trouble where instructions based on this theory have been disregarded.

I have gone somewhat lengthly into the subject as it is one of the most important questions with which we have to deal. Were we able to pen and ripen the fish we could extend our work to almost any extent at comparatively small cost.

The work has been extended as rapidly as circumstances would permit and in this we have been greatly aided by the

Bureau of Fisheries. The hatchery on Rainy Lake has been operated by men assigned to the work from the Bureau and the same holds true of all spawning work connected with the hatchery. One of their men has also operated the Ottertail hatchery.

With all our work the fish can be saved in large numbers only by rigid enforcement of our adequate laws. The conclusions arrived at from considering the notes on our work as a whole might be of interest.

Those streams, in which the water comes to a suitable temperature for spawning before the ice is out of the lakes, into which they flow, are the most desirable for spawning operations. The spawners come up in a well defined run and are ripe, or nearly so, when taken. The best spawning temperatures run from 45° to 50° preferably 46° to 48° though eggs are taken at as high a temperature as 63°. Eggs taken at the higher temperatures are as a rule poor. Good hatches have been made from eggs subjected to a temperature so low that slush ice has formed in the water, and this in instances where eggs had already been taken. Such conditions occurring when the run is on, invariably drive the fish down stream and stop the run.

We find that the egg bearing females will not ascend above the first swift water in any numbers while the males pass over rapids to a large extent. The females pass up and join them after depositing their eggs.

Below the rapids in Pike River we have found naturally deposited eggs forming a mass from 6 to 8 inches. These eggs were eaten by suckers during the night and another mass deposited during the next day. This sometimes was repeated for as many as three consecutive days. All efforts to hatch eggs taken from this mass were a total failure. Not one fish has been produced by such attempts.

The presence of eggs to this extent took place some years ago though even now there are places where the egg mass is considerable.

In most cases where an abnormally large loss has taken place in eggs, indications have pointed to lack of care during the hardening process. Rainy River is an exception to this rule and here pollution is a determining factor. Lack of care is generally the result of a sudden run producing more eggs than the crew and equipment can care for in the natural desire to secure the largest number of eggs possible. The combination results in loss unless the men in charge of the work have unusually good judgment.

A run of suckers is nearly always coincident with the pike run, though no other rough fish appear in numbers during the spawning time.

Discussion.

MR. CULLER: I understood Mr. Cobb to say that the unripe female came back after being thrown below the net.

MR. COBB: In certain places they do; in some places they do not.

MR. CULLER: It might be unnecessary to pen the fish then.

MR. COBB: In some instances where they come back we have no pens. Pine River, where the water is very clear, the fish come in at night but being unripe it is dropped out in the morning. In the evening it will start to work its way back upstream and will get into the trap again that same night. We do not pen where those conditions exist.

MR. CULLER: That makes it very much better from the fish culturist's standpoint.

MR. COBB: Yes.

MR. CULLER: In taking your eggs, what do you use, muck or starch?

MR. COBB: Muck.

MR. CULLER: Have you ever made an experiment with starch?

MR. COBB: Yes, we have tried it, but liked muck better.

MR. ADAMS: You spoke about the adherence of eggs in the jar. Has any experiment been tried with the view of dripping automatically into the jar a chemical that would not injure the egg but would be sufficient to counteract that tendency to pack or collect?

MR. COBB: I do not think so. We have never had any trouble except at that one place.

MR. ADAMS: You collect your eggs in very quick water?

MR. COBB: Yes.

MR. ADAMS: What gear do you use to take the adult fish?

MR. COBB: Pound nets.

MR. ADAMS: You cannot anchor them in the quick water, can you?

MR. COBB: We have succeeded in holding pound nets in water so swift that it took two men to row a boat up to them, and in a channel where we could not drive a stake—absolutely rock bottom. We ran two wings to the shore, and put the big pound there.

MR. ADAMS: But your debris goes down the river.

MR. COBB: We turn that to one side of the stream with boom logs run out by the leads.

MR. ADAMS: Then you have to have booms on the up-side of the stream —protect your trap in the same way?

MR. COBB: We put a boom up above the works on an angle across the river, and get the stuff away from our traps in that way. We fasten two anchor lines up stream on either side of the banks, but we use no stakes. In certain cases we put our pound into a frame, and anchor the frame and then drop the pound into it. Then we build from that to the end of the two leads, which are also fastened to trees on the shore.

MR. ADAMS: Assuming that on one side of a river the banks were gravelly and that on the other they consisted of a ledge of rocks projecting out to the bottom of the stream, would you endeavor to anchor that pound or trap toward either shore or more toward the middle of the stream?

MR. COBB: It is preferable in fishing for pike to get the pound where you can lead into it on the side of the stream where the fish are helped up at least a part of the way by a back eddy. It depends, however, entirely on the conditions.

MR. ADAMS: In the case of such shores as I describe, the pike will follow or be affected by the currents rather than by the contour of the shore?

MR. COBB: Yes. The female pike with the eggs will not work up in the swift current; they will take advantage of the eddies which help them along; and they hesitate when they come in that eddy to a point where they face directly into the swift current.

MR. ADAMS: Would you say that May 15th would be late enough in the year for the close season to protect the spawning pike say in Massachusetts? I believe that is your limit now in Minnesota, is it not?

MR. COBB: That is not late enough in Minnesota, and I presume it would not be late enough in Massachusetts. We had a great deal of trouble on account of the run being cleaned out by fishermen above our nets after being spawned and dropped over. We now have a law by which these places can be closed to fishing by the commissioner, which takes the fish over the spawning period.

DR. EMBODY: There was a point concerning the spawning of the pike-perch in which I was interested. I do not think anyone has ever adequately described the spawning behaviour of the pike-perch. At least, I have never found anything more than a general declaration that the pike-perch scatters its eggs over a sandy bottom, the sandy shoals near the mouths of rivers. Did I understand you to say that you had actually found eggs of pike-perch laid naturally in this river?

MR. COBB: Yes.

DR. EMBODY: And that they were massed together?

MR. COBB: They were massed together. Shall I describe the condition at that particular place? Slightly up the bay from the lake was a very swift rapid, and above that rapid we found almost no female pike with spawn. The males, especially the smaller ones, passed over there in great numbers. These pike came up to the foot of this swift water; they would wait there until they became massed in from the accumulation of numbers, then they would rush up into the current, come to the surface and break water; and in the large majority of cases when they broke water, with a sort of splurge or splash, they would throw a part of their eggs. Then they would drop slowly down to a little clearer water, stay there a minute or two as if recovering from their effort; and finally come up again. The eggs would drift down and gradually settle to the bottom, where they would adhere.

DR. EMBODY: I assume that would be a gravel bottom.

MR. COBB: It was a rock bottom. I may say that with extremely high water the swift current extends further down and sometimes reaches an accumulation of mud; and the fish will even spawn right on the mud bank if the swift current ends down there. Of course, that takes place only once in a long time.

DR. EMBODY: The disturbed condition of the water seems to be the primary factor. If that is the case, would they not spawn in the lake itself?

MR. COBB: They do, but our work is confined almost entirely to streams, because a large part of our fish do spawn in the streams, and where you can get a run passing one way in a stream you can do a great deal more business with the same amount of money and men than you can out in the open lake. But they do spawn in the lake quite frequently.

DR. EMBODY: I was interested to know if they did actually spawn in the lake. Or whether a stream was actually necessary. That might throw some light on the type of lake in which we ought to introduce pike-perch.

MR. COBB: I have seen a heavy run in Pike River driven back by snow. We had about a foot of heavy, wet snow. The water temperature went down to freezing point, and the pike left the river. The bay in the river at that time was free from ice, and we found that the pike were on the north shore of the lake, where the shore consists largely of broken rocks. They were spawning where the waves were breaking over the broken rocks, a good way from shore. They did not go back to the stream that year.

MR. DOWNING: When the female fish break water and extrude eggs at the same time, is the male with them?

MR. COBB: In some cases yes, and in some cases no. We have taken chunks of eggs that would fill a jar when you came to separate them—eggs some six to eight inches deep, over a space 175 feet across. On one occasion the pike were spawning all night; but a search in the morning would show the bottom clean. The same thing was repeated three days in succession, and at the end there were no eggs there except, probably, a few that you could find in the crevices of the rock.

MR. DOWNING: The moral is to dispose of your suckers.

MR. COBB: We have given large numbers of them away for many years.

MR. HARE: Have you any idea of the percentage that were fertilized among those you took from the bottom of the stream?

MR. COBB: We were not equipped to determine the fertilization, but we have made a good many attempts to hatch them. The whole thing needs more scientific study in order to arrive at definite conclusions. We never hatched a fish from eggs taken in that way.

MR. TITCOMB: Did you find any egg-bound fish among those that were turned back by change of temperature; or did you look for that?

MR. COBB: I have never found any in such cases.

MR. TITCOMB: In reference to Dr. Embody's question with regard to the movements of pike-perch in connection with their spawning habits,

I may say that in some waters tributary to Lake Champlain there are very large runs of these fish, but occasionally they are turned back by the temperature conditions and spawn largely around the lake shore. On Oneida Lake, in New York State, the principal run of fish is to the shores rather than to the streams, but they are apt to run to the streams. It depends on the conditions. If you get a rising temperature, causing the pike to start up the river, and then a sudden drop in temperature occurs, they back down and spawn around the shore; they do not go back.

MR. COBB: No, they will not go back that season.

MR. HARE: Mr. Cobb has presented a very important paper, because he has proved conclusively that modern fish cultural processes are absolutely correct, and that there is a tremendous loss in natural reproduction.

MR. COBB: One thing I did not mention in the paper—Mr. Titcomb's remark makes me think of it—is that the specific gravity of pike eggs has caused much of the trouble. The eggs in some cases are so light that we can hardly hold them in the jars, and our loss is tremendous from that cause. At the slightest motion of the water they run out of the jars and pass right down through our battery tanks and into the fry tanks.

PRESIDENT LEACH: What type of jar do you use?

MR. COBB: The Meehan jar.

MR. TITCOMB: You prefer that to the others?

MR. COBB: I could not say as to that, except that I believe in using the same type of equipment so that it is all interchangeable. I do not believe there is any difference in the various types of jars so far as capability of hatching goes.

MR. ADAMS: In the case of the quick water you have described, from the point where these eggs are extruded by the female about how far down stream are they carried before they are anchored somewhere? I recall your statement about the specific gravity of the eggs, some apparently being lighter than others, but I am getting at the average now.

MR. COBB: The egg sinks fairly rapidly in still water. In that case they pass directly down. But in a stream, where there is quite a swift current and the fish are thick they keep everything agitated. In this particular case the egg mass on the bottom began about at the lower edge of the swift water and extended down in a mass for about 175 feet.

MR. ADAMS: Where would they first lodge from the point where you think they were released by the female?

MR. COBB: Almost directly underneath, and from there for 175 feet the great mass of eggs was on the bottom.

MR. ADAMS: The wall-eyed pike has established itself in the upper regions of the Connecticut River, at Turner's Falls, Mass., particularly where the sides and bottom of the river are very rocky. It is the place these fish have selected as spawning ground, irrespective of the fact that some distance above there is an obstruction across the river that would prevent them from ascending. On the coast of Massachusetts we have a

run of salt water smelt, and it has always seemed mystifying to me how a little, delicate fish like the smelt could spawn in the very quick water and have practically all the eggs located right on the bottom and sides of the stream in the quick water. That is why I wondered whether there was much difference between the smelt spawning and the larger fish, such as the wall-eyed pike; apparently there is not.

MR. COBB: I am not familiar with the spawning habits of the smelt.

DR. EMBODY: Do I understand that you had a continuous mass of pike-perch eggs nearly one hundred feet long on the bottom?

MR. COBB: Yes. You could go out there, take a kick into it with your boots and kick up a bunch that would fill a hatching jar.

MR. DOWNING: There is one feature that Mr. Cobb has brought out which is very gratifying to me. He tells us he has almost absolutely controlled the taking and hatching of his eggs, whereas in our work the eggs are taken under the most adverse conditions. They are taken in small boats out on the open lake by the fishermen themselves, then we buy the eggs from them. All our receiving stations are from twelve to forty miles from our hatching stations. Some of our eggs are shipped on trains and have to be held three or four days. It gratifies me to say that under these conditions my hatch this year was forty-three per cent. They were taken just the same as any other egg, without the use of starch or muck.

MR. COBB: Our percentage was a little light this year.

MR. HARE: How can you determine your percentage on pike-perch?

MR. COBB: It is not tied down to a definite number. We do not make an exact count. We measure the eggs, and we measure the eyed eggs just as late as possible before the hatch. We keep watching the tanks for any that have died after the hatch. The loss is small from that time on. Sometimes we have something that offsets that, but that is what we take as a figure. It is quite accurate up to that last estimate, which might cause a variation.

MR. MANNFELD: Has Mr. Cobb ever tried to raise wall-eyed pike?

MR. COBB: Only to a very early stage; I have never got very far with them.

MR. MANNFELD: I want to tell you something of an experiment of ours in Indiana. Unfortunately, we have no waters from which we can take fish in order to strip them; we have to purchase our eggs. We have some friends in Michigan who have been kind enough to sell us eggs. Two years ago I wanted to see what we really could do with pike-perch fry. We planted between twenty and thirty thousand fry in a pond which had absolutely nothing else in it; we were first careful to make sure that the small insect life in this pond which would constitute food for the fish was very prolific. Along in September we gave a State Fair exhibit, and we took fingerlings out of the pond some of which were ten and a half inches long, some five or six inches long. When we drained that pond in the fall we had one fish that was seventeen and a quarter inches long. Out of the twenty or thirty thousand that we placed in

this pond we got 1,325. Perhaps that was a waste of pond area to rear these fish to the fingerling stage, but it developed one very important thing to me, that is, that that could be done.

MR. COBB: How large was the pond?

MR. MANNFELD: Over half an acre, and rather deep. We did not feed the fish; they fed naturally on the Daphnia, Cyclops and other insect life with which the pond was well supplied. At the Annapolis State hatchery there are twenty such ponds. In addition there are five others maintained by one of our Fish and Game Associations which are responsible for the fish collecting at this particular point. But we are troubled with crawfish. The little crawfish in this pond were the main food for the wall-eyes; of course, they feed on one another, undoubtedly. That experiment, however, was worth while, although we have not since repeated it because we can use our ponds better for the rearing of bass. We rear large and small mouth bass, ring mouth bass, bluegills and yellow perch, so we need all the pond area we can get for these purposes. We have tried to plant fingerlings. We figure that fingerlings are more valuable than fry. These particular fingerlings reared with the wall-eyes were planted in a space in the park that is perhaps half a mile wide, and we have some there now that are perhaps three feet long, weighing four pounds. We are trying to establish a place where we can have some breeders that we can strip right at Indianapolis. It may not be possible.

MR. COBB: Did you determine definitely what was the food of the young pike?

MR. MANNFELD: It was nothing but the natural food that was in the water. They were not fed anything.

MR. COBB: I would like to find out definitely what the first food of the young pike consists of.

HEADWATERS

By F. E. Hare,

Manchester, Iowa.

I have always appreciated the opportunity of attending meetings of the American Fisheries Society and the inspiration derived from associating myself with men who have reverence for the big out-of-doors, and the preservation of our national resources. Men of this type, it seems to me, are in the minority; consequently, many of nature's most gracious gifts to mankind have been sadly neglected and disgracefully abused. Such carelessness and disregard for the future welfare of the coming generations is a clean cut case of public neglect. However it is gratifying to know that public sentiment is gradually awakening to the supreme importance of this subject, and some very commendable legislation has been, and is now being enacted with a view toward better protection for these natural resources.

A particular subject under the broad head of conservation which has interested and impressed me vividly during the past few years has been what we commonly term, "Headwaters", and it is toward a realization of the importance of this phase of conservation that I would direct your attention, and then perhaps venture a few words suggestive of remedial measures, which we as sportsmen and lovers of wild life should consider.

I know it has been the privilege of most fishermen to visit the headwaters of a pure sparkling stream of water amongst towering hills or in virgin forest, and as you noted the rugged grandeur of the scene, were you not impressed with the peaceful and sublime surroundings?

I have in mind at this moment several mental pictures of these sacred sanctuaries which I have visited during the past few weeks, and I presume that many of you could conjure up in your mind's eye visions of similar beauty.

It was not without adequate sense of reason that the Indian, the true American sportsman, frequently took as his shrine the sparkling and apparently living waters of some crystal spring, the source of a limpid brook and a mighty river. For him the land of headwaters seemed symbolic of an infant, who gradually grew greater and wiser, until he

was finally lost in that mystic unfathomable depths of the ocean.

Can it be that I am a fanatic on this subject, or will you agree with me that the time is at hand when we shall come to realize that headwaters are of vital importance. Not only as places of surpassing beauty; but also as important factors in the life of the waters below. Truly, it is as impractical to believe that a crystal stream could emanate from putrid headwater as it is to believe that a golden pheasant could hatch from the egg of a sparrow.

It is true that many of our headwaters are not especially beautiful or economically important, or suitable for fish propagation; but this fact makes it all the more necessary that we should wrap the cloak of protection about those which we recognize to be of specific importance. By the most important headwaters, I refer to those streams which originate in strong flowing springs back up in the hills, that should be controlled and protected by state or national supervision.

Frequently, by the purchase of a comparatively small portion of land, springs and headwaters of this nature could be brought under the proper control, and be utilized for the purpose of prolific breeding places for water life, and incidentally, as ideal locations for parks. I would call your consideration to these in particular, and proceed at once to state my reasons for so doing.

In the first place polluted water is one of the most difficult problems with which we have to contend at this time. Therefore, it is my conviction that every state in the Union should employ a competent man to investigate headwater conditions in each of the respective states, to determine which are of most importance for fish propagation, and take steps to place them under state control, as a means of protecting them in their natural state of beauty and usefulness.

In many instances these headwaters contain ideal conditions for fish hatcheries, and in many other instances conditions are suitable for at least rearing adult fish for brood stock and egg collecting purposes.

In fact, I would call your attention to the Manchester, Iowa, Fisheries Station as an example of such headwaters, where successful fish propagation has been conducted for a quarter of a century. It has served as a delightful public pleasure resort throughout these years, where thousands of visitors find pleasure and recreation.

I have not traveled very extensively thru the rural districts of my adopted state, Iowa, however, I could cite a

number of headwaters in that state that should be thoroughly protected at this very moment.

A short time ago I visited a number of the public parks of Chicago. On inquiry I learned that some man or woman with a future vision had donated land for the worthy purpose of affording recreational grounds so long as time lasts. These parks are now regarded as the lungs of the. city. Similarly, we want these natural headwaters and the adjacent forests to become the safety zone for fishes and birds.

Finally, we should not forget that many destructive floods and the consequent loss of property are directly due to the deforestation of our headwaters. This is but another clinching proof of the need of headwater protection for the man who prefers the alluring song of a whirring reel, to the disastrous report of the woodmens' axe.

If we were all living in the proper relationship to this grand old world, corrective measures would speedily come as a natural result; but how are we to intensify man's appreciation toward mother nature and her children?

I have been wonderfully impressed with the writings of James Oliver Curwood, in the Isaac Walton League Journal. It is the voice of Curwood, and the still voice of Roosevelt and Isaac Walton, in co-operation with such organizations as the Audobon Society, American Fisheries Society etc., that are most effective in agitating sane and sensible methods of dealing with these important problems.

In conclusion allow me to impress the importance of headwaters upon your attention for the following reasons; Namely, prevention of source water contamination: ideal situations for fish propagation: suitable locations for public parks, and prevention of destructive deforestation.

As sportsmen with practical vision, I would be pleased to have you discuss the merit of headwater protection and suggest some plan relative to the most practical method of encouraging proper legislative measures for protecting the beauty and usefulness of our most valuable headwaters.

Discussion.

MR. FEARNOW: Mr. Hare has brought up some very important points bearing upon the necessity for protecting the headwaters of streams. Many of these headwaters are difficult to reach and for that reason afford excellent breeding places for fish. I think it advisable that laws should be enacted which would close these headwaters or these feeders of the main streams to fishing. The modern fisherman with his automobile leaves the city and goes far into the mountains; he is able to reach points that had been almost inaccessible in the past; he is seeking the headwaters and the places where the fish naturally reproduce.

Another thing we might consider is the advisability of carrying fish to the headwaters of these streams and planting them where they will be immune from the attacks of their natural enemies. One of the members of this Society last year made a very timely remark when he said that he would rather have one can of fish properly planted than half a dozen cans of fish dumped into pools where the larger fish congregate at fords and bridges. We might consider the necessity of using more judgment in planting fish as well as enacting laws for the protection of those fish in the small headwater streams. I do not wish to be personal, but I would like to remind you of a little stream in West Virginia. I always think of that stream with fond recollections because it was the stream wherein I used to dive; it was the old mill pond—Sleepy Creek. When I left West Virginia years ago that stream was practically depleted; there were no fish in it that amounted to anything; the people would go to the great Cacapon River and the Potomac River. Well, the Bureau of Fisheries planted, not in Sleepy Creek proper but in the tributaries of that stream, a quantity of fish; ample protection was afforded; the laws were strictly enforced, and to-day the organizations are going to Sleepy Creek on their fishing excursions instead of to the great Cacapon River and the Potomac. That is one way of increasing the supply of fish in public waters, and it seems to me that it is the most important way.

Mr. Hare has raised a very interesting question, touching upon many phases respecting the protection of fish, the enactment of laws, and the planting of fish, and I do not think the matter he brings up could be given too much consideration. We can interest the public generally through the Isaak Walton League; these men take special delight in carrying fish away up into the mountains. When we get the headwaters of our streams so thoroughly stocked that the supply of food becomes inadequate, the fish will know enough to come down stream and let the angler catch him. We might, therefore, consider the advisability of having enacted legislation which would close entirely the headwaters of certain public streams.

THE PRESENT STATUS OF THE LOUISIANA SHRIMP INDUSTRY

By E. A. Tulian,

Superintendent of Fisheries Division, Department of Conservation of Louisiana, New Orleans, La.

As mentioned in the opening paragraph of my paper on the production of shrimp in Louisiana read before this Society on October 10th, the United States Census report gave the total shrimp production of the United States for 1908, as 14,374,000 pounds, 60 percent of which, or 8,580,000 being produced by Louisiana. The U. S. Bureau of Fisheries statistics gave the total catch for 1916 as 43,942,105 pounds for the territory extending from the northern boundary of North Carolina to the western boundary of Texas, and which takes in nearly all of the shrimp territory of the United States. Approximately 53 percent or 23,160,586 pounds of this total was given as Louisiana's production.

At the time that paper was read, our study of shrimp and the shrimp industry, both statistical and scientific, had already progressed to such a point that I freely predicted in the closing sentences of that paper, that the time was coming, when the shrimp industry would expand as never before, yet in such a way that there would be no diminution of the supply even if the maximum possible yield was reached. Based on the severance tax actually paid to the Department of Conservation on shrimp produced in Louisiana during 1921, the total catch during that year had already risen to 34,992,443 pounds, a 50 percent increase over the figures of 1916. The value of this catch for 1921 to those engaged in the industry was not less than $3,000,000.

There was a small decrease during the year 1922, owing to the excessive pack of the canneries during the previous year, which the market could not absorb. This was not due in any way to a decrease in the supply in our waters and as market conditions have now been relieved, the indications are that the steady growth will continue. The present open season began on August 16th, with more vessels and tackle in operation than ever before.

The phenomenal increase in the shrimp industry has been due to several interrelated factors; the introduction of the trawl, the enforcement of certain close seasons, and the correction of wasteful practices, which factors will be discussed below.

The otter trawl for the purpose of catching shrimp made its first appearance in Louisiana during 1917. Its great advantage over the large shrimp seine as a labor saving device, often enabling one man to take the place of ten (10), and greatly increasing the shrimp output per man, was decidedly in its favor from the standpoint of the commercial fisheries. From four trawls operated during 1917, the number increased to 250 during 1919, and 983 during 1921. The number of shrimp seines has decreased over 50 percent during the same period. It is clearly evident that the increased catch of shrimp is entirely due to the trawls which opened up new territory, the bottoms of our brackish water lakes and bays and the coastal waters of the Gulf, whereas the seine operated to advantage only along the shores. Normally, the smaller shrimp take to the shallower waters, except when migrating through passes. The trawls need not necessarily catch the smaller sized shrimp during the open seasons, and during the colder months when the large shrimp take to deeper waters, there is a close season on inside waters where the smaller ones congregate, this season extending from December 1st to February 15th inclusive. The destruction of young shrimp, thus prevented, combined with the fact that the adult shrimp spawn in the open gulf where they are not as readily available during the breeding season, are in my opinion the factors which will permit still further expansion of the shrimp industry without reaching the critical point.

The department has had little or no difficulty in enforcing the close seasons and the observance of the law is attributable to the co-operation received from the more intelligent fishermen and dealers, and to the services of the departments field inspectors and other employees. Unfortunately, there has been observed now and then a disposition on the part of some of the fishermen to take undersized shrimp to some of the drying platforms where the management did not seem to realize the injury they were doing to the business by purchasing same and thereby encouraging business of dubious character to the detriment of a profitable and legitimate business a few months later. Some of the drying platforms referred to did not refuse to take shrimp measuring two and a half or three inches long. Platform operators have been warned that the purchase of any con-

siderable quantity of these small shrimp must cease or the provisions of the law which authorize the Commissioner to entirely prohibit the use of trawls in any inside waters, will be invoked and the violators prosecuted to the full extent of the law.

The situation in this respect is steadily improving and we now feel certain that the shrimp industry suffers a great deal less from the using of trawls than it did when seines were principally used. Besides, the salt water fisheries have certainly improved as a result of taking shrimp with this apparatus. It may be said, that our chief food fishes belong largely to the shore zone, and it is here that they find the best feeding conditions and protection in the shallower waters, since this zone of aquatic life presents a combination of conditions, typical surface and bottom fish are found here also. The seine catches all three zonal types of marine animals, and not only the commercial species but the young and old of most salt water fish are taken. Under average conditions of practical operation, it has been shown that if the number of shrimp or fish caught is considerable, practically the whole lot is doomed to die even if the bag with its catch is not removed from the water, a few worthless species such as gars, sharks, rays and catfish being the more notable exceptions. In the first place, a large percent of the small and young fish are gilled. Again the shrimp seem to give off a powerfully irritating secretion, probably an alkaloid. This in some way seems to poison the fish as most food fish taken out of a seine bag full of shrimp, otherwise uninjured, almost invariably die. There must also be considered the effect of concentration of the fish and shrimp. While the shrimp are being removed from the bag when it is in the water, the oxygen content, especially in summer is no doubt reduced to low terms, and besides, the mucous exuded by the fish, especially when great numbers of such species as menhaden are taken, is considerable. This settles on the gills of the fish, much dirt adhering to it, and thus further prevents respiration.

Trawling takes place generally in deeper water, and usually only bottom species are taken. Of our food fishes, only four species, are taken to any extent in the trawls. These, with one exception, the gulf flounder, may be considered second class fish, and of less commercial importance than the important shore and surface feeders. As they are all found over great areas and in great abundance, the number actually destroyed may be relatively insignificant. Besides, several factors inherent in the trawl itself, and the method of operating, seem to permit of the escape of a great

number of the small and young fish alive. In the first place, the secretion produced by the shrimp is continually carried away by the current of water passing through the trawl, and its effects must be certainly minimized. Next, the smaller number and aggregation of fish, especially the absence of such abundant species as menhaden, and washing away of what mucous there is prevents the accumulation on the gills as in the case of seines. The smaller bulk of the catch and the shorter time required to unload and separate the catch are also factors to be considered. While the catch is being scooped out, the trawl is generally dragging through clear clean water at the surface, instead of the muddy water near the shore. Another thing must not be lost sight of. Typical bottom species, being associated with mud, natural pollution, and less oxygen, are fortified by nature to resist these conditions, and therefore those food species caught in the trawls are generally the very ones which survive above all others. Those returned to the open water, especially during the colder months, stand a much greater chance of survival than the less hardy shore or surface feeders or for that matter than the same species liberated from the seines in shallow muddy water.

Another factor in favor of the trawl is that most large fish seem to escape, no doubt due to their own alertness and rapid swimming. The rate of motion of the trawl is relatively slow and the disturbance is sufficient to permit their escape. The shrimp seine on the other hand catches large and small fish of all kinds because of the large area surrounded. The escape of the large fish from the trawl partly compensates for the young of any species destroyed.

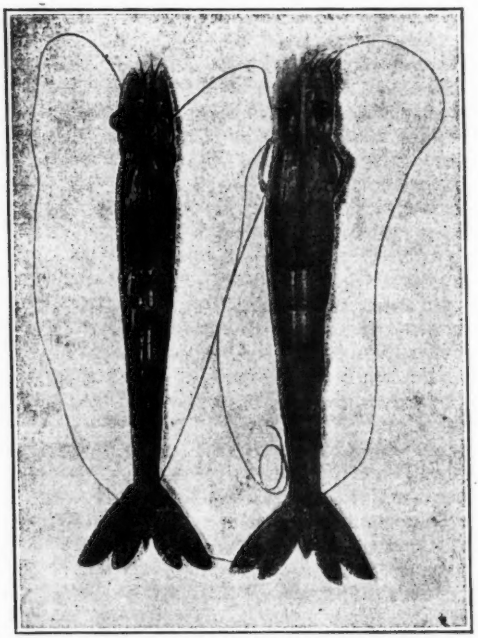
Since my last paper before this Society, there has been done much research work pertaining to the life history of the premiere shrimp found in our waters, and Mr. Percy Viosca, Jr. M. S. Biologist of the Fisheries Division of the Department of Conservation of Louisiana, has gotten together a great deal of information on this subject. His previous work has been amplified and as a consequence, the Department possesses more intimate knowledge of the life history and habits of the shrimp, Penaceus setiferus, than any other denizen of our waters. Many of the remarks made in this paper are based on his field observations.

I will conclude this paper by incorporating bodily, a report made by Mr. Viosca to this Department, which summarizes our present day knowledge of the life history and habits of Penaeus setiferus.

"The following is a summary of the results of studies of Penaeus setiferus, which have been taken up since July

1918, when the research in connection with the work of the Fisheries Division.

"As comparatively little was known in a scientific way about this common prawn of our salt and brackish waters, better known locally as the lake shrimp, and as its habits



Penaeus setiferus 1-2 natural size. Immature female on left, sexually mature female on right. Note that while longitudinal growth has been slight, there has been considerable expansion in width especially in the region of the cephalothorax to make room for the developing eggs. This transformation usually takes place when the shrimp attain a length of six inches.

and migrations were very confusing even to fishermen best acquainted with it, we had only a small foundation to begin with, including the writer's limited previous experience. Furthermore, owing to insurmountable difficulties in the way of rearing the species in captivity with the facilities at

hand, observations had to be made entirely in the field; little by little, bits of information regarding its life history, habits and sexual development being gathered, often under adverse conditions, and now, after putting these together we consider that we have at least a substantial foundation for further inquiry. Furthermore, the advent of the otter trawl, which was to revolutionize the industry, made it imperative to accumulate all the grosser facts possible regarding shrimp, especially those most readily and rapidly available, so that they could be applied in a practical way for the preservation of the species and the industry if that was found to be necessary.

"Although, we have gained some headway with our study of the early life of the shrimp, we must still look to the researches of Fritz Muller and W. K. Brooks for the larval stages in the development of Penaeus. We have really only a fairly complete knowledge of the development and migrations from the time they enter shallow waters when they abandon their plankton life at the size of 1¼ inches, until they return to the sea as fully matured adults for spawning.

"Ecologically, Penaeus setiferus is associated with the sharky clay deposits precipitated by southern rivers upon bay and gulf bottoms, and as a consequence of Louisiana having much the largest river, we have much the largest shrimp territory along the coast of this State. The species is not associated with larger living vegetation of any kind, the schools moving over soft mud bottoms where they feed as scavengers upon organic material picked up in the ooze. They avoid sandy bottoms, especially those composed of coarse or compact sand. The breeding season, a rather extended one, includes at least the period from April to October, and is confined to the waters of the gulf, although ripe adults may come at times rather close to the gulf beach, especially during calm weather.

"By May, reasonable numbers of baby shrimp appear in the shallow waters near the coast line and a large proportion gradually migrate into brackish waters, all growing rapidly throughout the summer. New schools of young shrimp are continually coming in from the sea in greater and greater numbers as summer advances. As they grow older, they generally seek the deep water zones of the bays or lakes in which they happen to be, and the schools are usually of uniform sized individuals. Only a negligble percent remain in the sea throughout this growing period of their lives, and it is very evident that conditions there are not suited to their development. The maximum sized indi-

viduals of this generation born in the spring reach a length of six inches by the middle of September a rate of growth of not less than one (1) inch per month throughout the period. At this size there is a return migration to the sea, and adult sexually mature specimens which are always

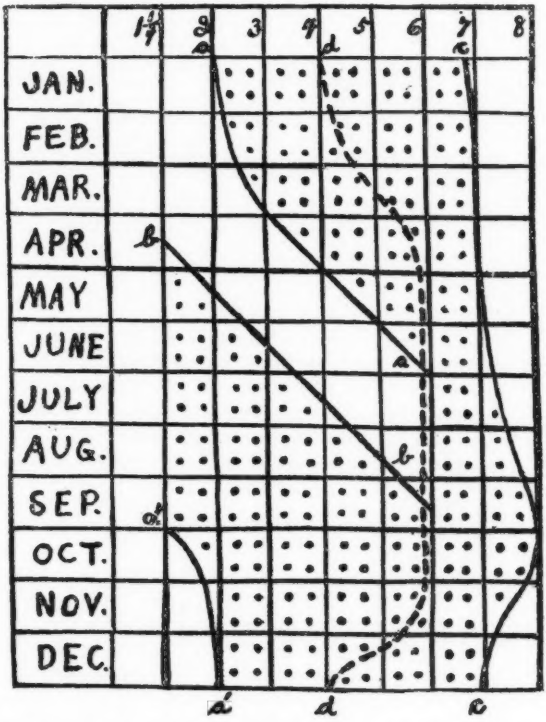
Shrimp trawl operated from power-boat.

over six inches are never found in inside waters, the only recorded exceptions being individuals caught in large passes leading in from the sea and only on inrushing tides.

"When cold weather approaches, spawning ceases and the rate of growth of the young which have not reached maturity is greatly slackened, later becoming practically checked during December and January. Because of winter rains, there is usually at this time a temporary seaward migration, even of very young individuals, these also seeking deeper waters during cold weather. As the warm season approaches, growth is quickened and the small individuals

resume their erratic movements until they approach maturity, when a definite migration to the sea can be traced. This can be followed easily by watching the growth of the smallest individuals which came in late the previous summer, and wintered at a size of 2 inches. These all reach maturity and go to sea toward the latter part of May, and as the new crop of babies is just beginning to come in, there are practically no shrimp of any size in the inside waters for a certain

Diagram illustrating the sizes of shrimp (**Penaeus setiferus** found in Louisiana throughout the year.



In the above diagram, measurements are in inches, represented by the vertical lines, the dotted squares indicating that shrimp between those sizes are present in appreciable abundance during the corresponding months. The blank spaces indicate that shrimp of those sizes are

not obtainable, except that shrimp under 1¼ inches, which are plankton larvae, are not included in the table. All shrimp approximately six inches or over can be considered as adults, while all between the sizes of one and a quarter and six inches while possessing the ultimate form of adults, are immature sexually.

Curve (a) (a) indicates the rate of growth of the minimum sized individuals of the so-called spring crop, which is in reality the small shrimp left over from the preceding fall, (a) (a) which grew very little during the winter. Curve (b) (b) indicates the development of the maximum sized individuals of the summer crop.

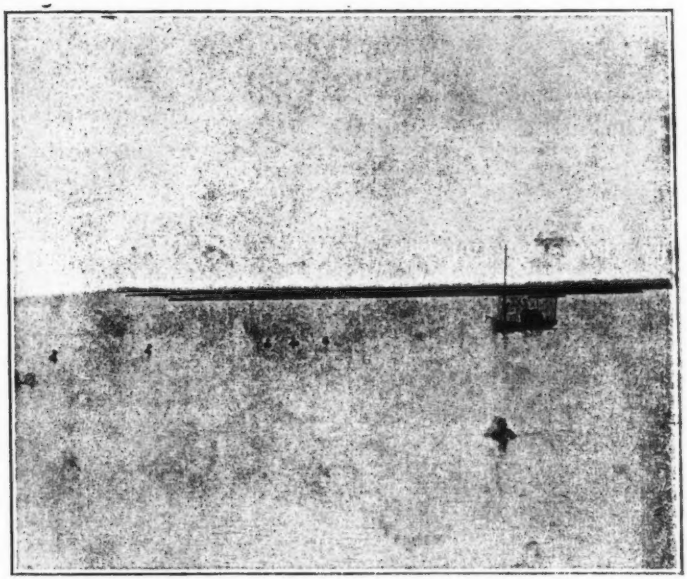
After reaching maturity, this rapid rate of growth evidently ceases, so that we find individuals varying somewhat in size, at all seasons of the year. During the summer there is an increase in the average size of the adults and the maximum sized specimens obtained in the littoral zone of the gulf during the various months are represented by the curve (c) (c). The sizes of shrimp to the left of the dotted curve (d) (d) represent average sizes of shrimp taken from inside waters while sizes to the right of this curve are from average measurements of shrimp from outside waters in the littoral zone of the gulf, usually from near the beach to five miles or more off shore. Such a strict line cannot in reality be drawn as shrimp varying about an inch either way of the sizes represented by the curve can be found both in inside and outside waters though usually near the coast and in the passes. Besides, there are many minor variations to be considered, caused by irregular natural causes. Although this curve (d) (d) is arbitrary and variable, it represents the approximate age at which immature shrimp migrate back towards the sea during the various seasons, they being much smaller during the winter months when the cold weather migration becomes somewhat confused with the permanent seaward migration.

period. The length of the period in which no shrimp are found widens as we leave the coast line and in such lakes as Ponchartrain and Salvador it is greater than the period during which shrimp are found. In some lakes farther inland they may even appear only every few years and then only for very short periods during the late summer. As growing shrimp migrate with the tide, they can be considered an excellent index to the presence of sea water however small the amount."

"Much has been learned of the sizes and quantities of shrimp present in various localities under varying conditions and the sum of this knowledge has been tabulated and in condensed form is herewith graphically presented.

"As shrimp under three inches are never taken in considerable quantities by the fishermen because they are of no commercial value, and as they are not usually associated with the larger sizes, they hardly need be considered in the formulation of a close season on shrimp. Protective measures should be devised more for the purpose of protecting sizes between three and five inches and a study of the table will clearly indicate during which months of the year a close season should be recommended.

"The table should also be applicable to conditions along other sections of the gulf coast of the United States throughout an average summer, but might have to be modified to apply to conditions in a different latitude.



Hauling a long shrimp seine—a method of catching this sea food that is being discarded in favor of the trawl.

"Now that we know something of the habits and habitat of the adults, and the general development of their sexual organs, we are in an excellent position to secure fine specimens of all stages, for the preparation of slides for more detailed miscroscopic study, without which we cannot be sure of the exact extent of the breeding season. Until this and other equally important basic scientific problems concerning shrimp, all of which have significant and far-reaching economic value, are worked out in great detail, we cannot expect to conserve this great natural resource with the fullest measure of success, by constructive legislation."

Shrimp on drying platform protected against rain by tarpaulins.

Discussion.

DR. EMBODY: Are there any questions on the subject dealt with in this very interesting paper?

MR. TITCOMB: May I ask what the density of the salt water was in which you found the shrimp?

MR. TULIAN: They come up into Lake Ponchartrain and Lake Salvador where the density is about one per cent.

MR. FEARNOW: I wonder if I could get some information in regard to the shrimp that are found in great abundance near the spillway at the Gatun dam in the Panama canal. The shrimp are found there two or three inches thick all over the concrete work. Apparently they are trying to get into fresh water. Is it the habit of the shrimp to go into fresh water at certain periods?

MR. TULIAN: There are three or four different varieties of salt water shrimp. Probably the one you refer to is closely related to what we call the river shrimp—fresh water shrimp. It is considered a delicacy in New Orleans.

MR. FEARNOW: These shrimp came out of the salt water and got on to what is known as the apron, right below the spillway.

MR. TULIAN: If they had got into the fresh water it would have done for them.

MR. FEARNOW: They were up on the walls to a great height.

MR. TULIAN: Probably there was a certain amount of salt water up to the apron.

MR. FEARNOW: No, there was salt water to the apron, but the apron is 300 feet long and the water is very swift on it. It is fresh water.

MR. TULIAN: The fresh and salt water mixes below the apron. The fully matured shrimp do not go up, but the small ones start to go into the brackish waters and there they stay until along in the fall; sometimes even in the winter they are found there. In Lake Ponchartrain and all these lakes connected with the gulf, during a season like this when there is a great deal of rain and large amounts of fresh water coming in, the shrimp do not come up as far. There are three of four different varieties, of course; I was speaking only of the particular variety known as the brown shrimp or commercial shrimp.

MR. FEARNOW: These seemed to be disappointed shrimp, it seemed as if they wanted to go up into the lake proper.

MR. TULIAN: They were lucky they did not get into fresh water.

MR. MARK RILEY: How do the shrimp in Louisiana compare with those we have in Texas?

MR. TULIAN: You have about the same kind. We have had a considerable correspondence with your commissioner over there. They are opening up quite a shrimp industry in Texas. No state has ever equalled Louisiana in that respect on account of her thousands of miles of brackish bayous.

DR. OSBURN: Does the industry extend right over to the Florida coast?

MR. TULIAN: Yes, they are catching large numbers along the lower Atlantic coast of Florida.

SOME CONSIDERATIONS CONCERNING THE CANNING OF SARDINES

By Harry R. Beard,

Assistant Technologist, Experimental Laboratory, U. S. Bureau of Fisheries, San Pedro, California.

Sardine canning in the United States is carried on in two localities, the coast of Maine, from Portland north to the Canadian border, and on the California coast from Monterey south to Mexico. In 1922 over two and one-half million cases were packed, having a value in excess of nine million dollars. These figures place this industry next to that of salmon canning in importance and, excluding Alaska salmon, first among our canned fishery products.

Although other products are canned, the output in Maine is essentially "quarter-oils" being small herring with oil in flat cans of approximately quarter pound capacity, while in California the pack consists almost in total of from four to ten large pilchards or sardines, with tomato sauce, in fifteen ounce flat oval cans, giving the so called "pound oval" pack. "Quarter-oils" are also canned in California and, in Maine, small and large fish are put up in mustard and tomato sauces.

The general method of preparation in Maine is to salt the fish lightly or place them for a short time in brine, after which they are spread on wire trays, next steamed and then partially dried by moving warm air. When cool, the fish are packed into cans, covered with oil or sauce, sealed, and next cooked and sterilized in hot water or steam. California sardines are usually brined, partially dried, pre-cooked in hot oil, cooled, packed into cans with the proper sauce and exhausted. After sealing the canned fish are cooked and sterilized in steam retorts. Some fish, however, are pre-cooked by steam in California and by hot oil in Maine.

With the view in mind of aiding in the protection of cheaper, yet at the same time better packs of sardines, the U. S. Bureau of Fisheries has been experimenting upon the technology of sardine canning in its Experimental Laboratory, San Pedro, California. Much research has been conducted yielding results most interesting and practical. It is the work which will now be briefly described and discussed.

A first view of the sardine industry shows that a variety of packs are produced and by methods apparently quite diverse. Even the same method is seldom alike in any two canneries. Closer study reveals, however, that the production of all canned sardines is dependent upon a few well defined factors, which are: (1) the fish themselves, including their condition, handling and cleaning; (2) the preparation of the fish for canning; (3) the materials placed in the can with the fish; (4) the canning procedure itself; and, (5) the chemical and physical changes which take place within the can during processing and later storage. Much is known about some of these factors and less about others. In any case, however, good methods of bringing about desired results and of obtaining excellent final products are known and practiced, yet it is reasonable to assume that a better understanding of underlying principles and of more economical methods of accomplishing the ends sought will be of assistance, perhaps to a very material degree. This is especially true concerning factor (2), the preparation of the fish for canning; and it is for this reason that the investigation has so far been directed into this field.

The first problem taken up was a study of the changes which take place in oil used for frying sardines. This, because of the rapid deterioration of the oil used, presents a problem of importance, especially in California where precooking in oil is the usual procedure. Under operating conditions, starting with a bath of fresh cottonseed, or other oil, the oil in the fry-bath rapidly darkens in color, becomes viscous and acquires a characteristic paint-like taste and odor. Part of this oil, although perfectly sanitary, finds its way into the canned product with results which are displeasing to some. The expense of frequent renewal of the oil is so large that it is impracticable. Attempts to diminish these effects and to recover the used oil by mechanical or chemical treatment have met with little success. In studying this problem experiments were conducted which show the nature of the changes taking place and indicate the direction in which improvement should be made.

The results of the investigation may be summarized as follows: Fish oil is present to a greater or less extent in oil used for frying sardines. When the fish are placed in the fry-bath, oil is rendered from them and mixes with the oil already present. Upon removal the cooked fish mechanically carry away some of the resulting mixed oils but leave some of their oil, thus increasing the percentage of fish oil in the fry-bath. When fat fish are fried this increase is so rapid that it is only a short time before the fish are being

fried in an oil which is largely fish oil. It can be shown by calculation that under conditions which are frequently paralleled commercially, the oil will be over 90% fish oil after 25 hours of service.

The use of corn oil or a hydrogenated oil such as Crisco, in addition to cottonseed oil, was found to be feasible for frying purposes. However, under conditions just described it is evident that it makes little difference what oil is used except at the first.

The presence of varying quantities of fish oil, and the action of air and heat, are largely responsible for the changes which take place in fry-bath oil. Under existing conditions the fish oil content of fry-bath oil is not open to control, but the bad effects due to air and heat can be lessened by diminishing to a minimum the action of these factors. Fry-baths should be constructed so as to offer minimum exposure of oil to the action of the air. By using the smallest possible amount of oil for the purpose, replacements will be large and this will diminish the effects coming from the action of the air and heat upon the oil.

Attempts to reclaim used fry-bath oil by chemical treatment were unsuccessful. It is not probable that a satisfactory cheap method will be developed.

In concluding, it may be said that although some of the difficulties of frying in oil are inherent much can be accomplished by attention to the following points: construction of fry-baths which use the minimal possible quantity of oil for the purpose; maximum protection of the oil from the action of air and heat; removal of frying oil to as great an extent as possible from the cooked fish before canning; and more frequent oil removal, using cheaper yet high quality oil.

The second problem taken up was a study of methods of preparing fish for canning as sardines. It is evident from a consideration of the first investigation that some of the difficulties incident with frying in oil can be materially lessened and that further study, especially upon the design of equipment, offers promise, yet certain troubles undoubtedly will still exist. Elimination of the necessity of frying as a step in the preparaton of sardines for canning presents a most desirable field for investigation. This was and still is especially true in California where, at the time of planning the investigation, considerable interest was evident, yet little known about methods of accomplishing this end, and as to how fish prepared in ways other than frying would withstand storage and shipping. No commercial attempt in this field had yet been satisfactory. Frying in general,

had already been eliminated in Maine, because a steamed pack was much cheaper to prepare. Steaming as done there, however, is evidently not suitable for California use. In this study three methods of preparing the fish for making the California "pound oval" pack were investigated, samples prepared, stored and shipped. These methods (named from a characteristic step in the process) are: steaming, cooking in brine and packing raw.

The preparation of fish for canning can be shown to be essentially a process of removing excess water from the fish and getting them into good physical condition for canning. If sufficient water is not removed from the fish—sardines let us say—before being sealed in the can they will shrink badly and give up much water during the sterilizing process. This gives a slack, so called "sloppy" pack which not only presents a poor appearance when opened, but is in no condition to withstand the treatment it might receive in being shipped.

Study shows that the procedure used when the fish are fried is an excellent one for removing water from them. To succeed, another process must accomplish this same end. If this removal of excess water is well done, and if the fish are in good physical condition when packed, a very good product will be obtained having satisfactory keeping and shipping qualities. This has been shown to be the case with the experimental packs put up by the different processes.

The big drawback to the steaming of California fish, especially fat ones, is that the skins break badly during the process and that they then stick to the trays and to each other when cold. Brining and drying before steaming, especially the latter, were found to lessen, but not eliminate, these bad effects, as does the use of trays the wires of which are oily. The preparation for canning them in this method is to brine, steam, drain and cool the fish. Good results were also obtained by packing the well dried fish into cans, inverting them to facilitate draining and then steam.

Instead of passing the fish through hot oil, simmering strong brine may be used. The fish should first be dried, but not brined, as this combined with cooking in a salt solution gives a too salty final product. This same trouble is encountered when small fish are used so the method is not applicable to the preparation of "quarter-oils." A tendency towards a too salty final product can be met by leaving the salt out of the tomato sauce. Although not so pronounced as when the fish are steamed there is found to be some trouble in this method regarding the sticking of the cooled fish to each other and to the wire trays.

When fish are packed raw, brining and drying alone must remove the necessary water, therefore, these steps must be well carried out. Brining removes some water and to make the most of this step the fish should be kept in saturated brine as long as possible without making the final pack too salty. The fish are then well dried and packed into the cans raw, with thick tomato sauce. Any water which cooks out of the fish is taken up by the thick sauce. A disadvantage encountered here is that the canning process must be completed within a few hours after the preliminary preparation, which is a disadvantage compared with precooked fish which may be held as long as 48 hours before being packed.

Time is not available here for a full discussion of the advantages and disadvantages of the different methods of preparation just described. These, as well as other angles of the problem and an elaboration of the parts of this paper, including the experimental data are now to be taken up in a Bureau of Fisheries bulletin which is now being prepared.

The third problem selected for study was the partial drying of such fish as sardines for canning. So far, the removal of some water from raw or steamed fish by subjecting them to the action of moving, warm air, has been an essential step in all successful methods of preparing fish for canning as sardines. Commercially the fish are scattered upon wire trays or belts contained in a tunnel through which air is blown or drawn, the air being heated by first passing over steamcoils. The principles involved in this method of removing moisture and their best application are in general unknown to the sardine canner. Then, too, the behavior of raw and cooked fish under various drying conditions has not yet been worked out. Accurate knowledge of this latter point is necessary, to permit the practical application of the fundamental principles of air drying to the designing of apparatus and to the improving and cheapening of this important step in the preparation of the fish for canning.

This problem was approached by first studying air drying in general, followed by the construction of an experimental dryer which was used in investigating the behavior of raw and steamed fish under the different drying conditions. Data were also obtained upon commercial sardine dryers and their operation.

Before going into the results of the experiments it will probably be well to discuss briefly the part drying plays in the preparation of the fish for canning and the nature of air drying.

Air drying is resorted to in Maine after the brined raw fish have been steamed. These cooked fish still contain too much water to can well so they are partially dried. Drying of raw fish, however, prior to some form of pre-cooking presents a somewhat different problem from that of drying steamed fish or fish to be canned raw. In these cases the problem is more largely one of moisture, but to prepare fish for pre-cooking the most important thing is to get them into good physical condition for withstanding the rest of the preparation for canning. It is a process of toughening the skins and the removal of surface water and some internal moisture so that the fish will undergo frying, steaming or cooking in brine with minimum damage to themselves. The actual amount of water removed is of secondary importance and may vary some without detriment to the final pack, especially if plans are laid to remove more or less water in the subsequent preparation.

If one looks into the nature of air drying it will be found that when air is heated it has a greater moisture absorbing capacity at the higher temperature. It is therefore possible to take air which is already saturated with moisture, (as on a rainy day), heat it, and use it for drying fish. The moving, warm air striking the fish warms them, furnishing the heat needed to vaporize the water and then carries the water vapor away from the fish. With other conditions equal and favorable, an increase in the temperature of the air, or in its velocity, or a decrease in its moisture content, will bring about an increase in the amount of moisture removed from an object being dried. The application of these principles is limited, however, by the physical and chemical properties of the object being dried, and practical considerations which present themselves.

The experimental work upon the behavior of the raw fish under different drying conditions has shown that the amount of moisture in the drying air has but little effect upon the rate of moisture removal from the fish, providing no condensation of water on the fish takes place. Increasing the temperature, however, brings about a marked increase in the amount of water removed and this is also true for increased velocity. With other conditions equal, either an increase in temperature or in velocity will bring about greater heat transfer from the air to the fish, thus increasing the vaporization of the water, and its diffusion from the interior to the surface. In this way a greater loss of water from the fish is brought about. High temperatures acting upon large "pound-oval" size fish for any considerable length of time softens them considerably and causes some oil

to be rendered from them. For example, one hour exposure in the dryer to a temperature of 120 degrees Fahrenheit brings about these undesirable changes while one-half hour does not. The fish enter the dryer at or below outside air temperature, say 60 degrees Fahrenheit, and then the temperature near the skin gradually rises towards that of the drying air. During the first 30 minutes the temperature may vary from 60 to 100 degrees and during the next 30 min- from 100 to 110 degrees Fahrenheit. It would appear from this example that the undesirable changes take place after the fish attain a temperature of over 100 degrees. The experimental evidence shows this to be the case with the limiting temperature possibly a few degrees lower.

To use the higher temperatures, then, times must be cut, yet it is found that if this is done the total moisture loss is quite the same as at the lower temperatures with their longer drying times. The fish are in excellent condition for frying, too, and do fry perfectly satisfactorily. This angle of the drying problem is a most important one, for it is entirely possible that future study along this line may mean a great deal; at least the preliminary work gives such a promise.

Drying conditions being equal, small fish will lose water more rapidly than large fish. The rate of loss in any case varies with the time; the percentage loss being considerably larger during the first unit of time and after that, more nearly equal for each succeeding unit of time. In no case were fish dried longer than three hours.

Steamed fish lose water much more rapidly than raw fish; otherwise they behave quite similar to raw fish under different drying conditions. Much research, however, was not carried out on steamed fish; this to be done later.

In the California industry where accurate data on commercial dryers were collected, temperatures from 75 to 120 degrees Fahrenheit and velocities from 350 to 1450 feet per minute were in use. Times varied from 28 minutes to about 3 hours, with losses on large fish running from 3.8 to 10.7 percent. In all cases fish were being dried for frying in oil. One canner was getting 3½ times the efficiency from his dryer that his next door neighbor was and they are both big successful plants.

Having available data upon the behavior of the fish and knowledge of the role of drying in the preparation of the fish for canning, one is able to make better use of the general principles of drying and their application as embodied in dryer design. This means that present equipment and practices can be made much better and future installations smaller and more efficient than the ones now in use.

Experiments have shown that an important cause of slow drying on certain days is due to a lack of drying for a short time when the raw fish first enter the dryer. The fish may come out of the brine with a temperature several degrees below the dew point of the air in the dryer and in that case there is some condensation upon them until they are warmed to a temperature above the dew point, and not until then does any drying take place. Several methods of handling this difficulty are available, the question, however, is to pick the best. This is going to be a part of the future research to be carried out in the drying field. How to increase the amount of air which may be recirculated in the dryer (and thus save heat) depends in part upon a solution of this problem. It is also planned to further investigate the drying of steamed fish and to study existing commercial installations used for this purpose. The most important work, however, will be upon the use of high temperatures and short times for drying raw and steamed fish.

A field of major importance is the use of live steam in the preparation of the fish for canning. It is planned therefore, to make a study of this problem. This is, at present, primarily a question of the Maine industry.

So far, all actual experimenting has been upon California fish and although most of the results can be applied to problems in Maine, yet there are commercial aspects and questions as to the behavior of the fish which must be settled. Some experimenting in Maine with the fish there will give the desired information. This is going to be done in the future.

Much of the effect of industrial research of this type and of as general a nature as this has been, is bound to be more or less intangible; however, concrete evidences of its value are beginning to collect. So far only the work upon "Changes in Oil Used for Frying Sardines" has beeen published. The rest, as previously stated, is now being prepared for publication.

The results of the investigations and their application to the problems at hand have been discussed with the California sardine packers, most of whom state that they are being of material assistance to them. In the case of a cannery just getting ready to install equipment for sardine canning on a large scale, it has been possible to plan a dryer which, per ton of fish handled, will occupy considerably smaller space and cost much less to build and operate than any California sardine dryer heretofore in use. The frybath is also being designed so that material economies in the use of oil will be effected. In several other cases

changes in existing dryers are being made so that their capacity may be increased.

In concluding this discussion, attention is called to the fact that during a lapse in Congressional support the California State Fish and Game Commission met the expense of the investigation upon "Changes in Oil Used for Frying Sardines" and later contributed some towards the study of "Methods of preparing Fish for Canning as Sardines." Appreciation is also expressed for the willing cooperation at all times shown by the sardine packers.

PROBLEMS IN BASS CULTURE AT THE COLD SPRING, GEORGIA STATION.

By Charles A. Bullock
Bullockville, Georgia.

Before reading the paper I want to describe the conditions that prevail in the territory served by our station, approximately the eastern half of Alabama and the western half of Georgia.

So far as conservation or fish protection, in any sense of the word, are concerned, we have none. Bass, trout, bream and catfish can be taken at any time during the year. There is no well enforced restriction against seining for game fishes at any time of the year. Under such conditions it easily will be understood that the public streams have been sadly depleted of their game fishes.

The people, down there, have apparently given up all hope of remedying conditions through their legislature, and therefore have built, and are still building a large number of private ponds. A very large part of the output of our station is distributed to furnish an initial broodstock for the development of these ponds. This paper treats of our problems in supplying the demand.

A systematic effort has been made in the last six years, to lower the unit cost in the production and distribution of young bass; and, as rapidly as possible, to increase the output in order to meet the constant increase in demand.

Unit costs have been kept low by having all such skilled labor as carpentering, plumbing, painting, blacksmithing etc., performed by the personnel. Increasing our area in pond waters by one-third was also accomplished by the crew with the addition of a single temporary laborer. And in all labor, skilled and common, the superintendent not only directs but feels privileged to share a fair part.

While providing for an increase in the output through increasing the size of the plant, the possibilities from intensive culture were not overlooked.

Three springs furnish our ponds with water. They are close together, so the quality is about uniform for the three. It has never been considered a good fish-producing water. It is deficient in dissolved mineral elements, particularly in calcium, so necessary in producing an abundance

of the minute crustaceans on which the baby bass feed. It is also deficient in all the elements that, under the action of bacteria, change the dying aquatic plants into humus.

Of calcium it contains less than one part per million. At some of the other Bureau's stations the parts per million are: White Sulphur, W. Va., 14; Erwin, Tenn., 17; Neosho, Mo., 37; Wytheville, Va., 50; Northville, Mich., 60; and Bozeman, Mont., 65. A comparison as to many of the other elements would show a similar disparity. In free carbon dioxide Cold Spring water is rich having 60 parts per million.

The effect of a difference in amount of mineral elements is clearly shown by a comparison of the higher aquatics that thrive at the stations mentioned with those that grow at Cold Spring station. In the ponds at these stations are found Chara, Water Cress, Potomogetons, etc. In our ponds grow water grasses, sedges, rushes and Starwort. These are the native species. The Milfoils and Pennywort, introduced species, also thrive.

On our fish the effect of the deficiency in minerals in solution and the presence of considerable free carbon dioxide is shown in the high mortality of adults, often one-fourth the total number, and in the number and thrift in schools from domesticated stock when compared with the greater numbers and more rapid growth of schools from wild bass newly introduced from South Georgia waters.

A number of experiments have been made with the purpose of improving the quality of the water and of enriching the bottom soil of ponds. One year a carload of stable manure was broadcast over the drained ponds and worked into the soil. It failed to decompose into humus properly and the results were negative.

The next year a carload of limestone, crushed to pass through a screen of 100 mesh per inch, was applied to the pond bottoms. No benefit could be claimed.

This year a filter was made in a single pond. It contained, above the gravel and sand, a barrel of newly slaked burned lime. Water was forced up through it from a three-fourths inch pipe under a half pound pressure. Installed and put into operation last September much of the lime had dissolved out by the time fish began spawning. Though many eggs were spawned, no fry or fingerlings could be found for collections, so about the first of May the filter was disconnected. After that the pond gave good results; perhaps as good or even better than any other on the place. The results were not conclusive.

The problem of providing a better fish medium was undertaken in another way, beginning last summer. Ponds

were drained as soon after July 15th as we failed to find schools present and the work could be begun and completed.

Three purposes were in view; first to sweeten pond bottoms by letting air permeate through them as long as possible; second to have summer suns and winter freezes destroy the undesired weed, Pennywort; and third, and most important, to reduce the number of carnivorous insects. We had too many giant water beetles, Dytiscus, giant water bugs, Benacus, water mites, water scorpions, small diving and whirligig beetles, etc.

The results were satisfactory. The warm weather last winter spared too much of the Pennywort, but carnivorous insects were very scarce this season while more daphnids could be seen along the shores in the early months than in all the previous five years combined. The final proof of the advantage of very early drainage is shown in the output. It was much larger this year, as compared with any other in the history of the station.

The food given to bass at this station had always been chopped fresh mullet. It is a species rich in oil; the many dead bass examined showed the stomach surrounded by a mass of fatty tissue, and it was thought that perhaps the food might, in part, account for the high mortality, besides the cost of mullet seemed prohibitive.

Grouper and other fish were offered the bass as a substitute, but were refused. Next strips of beef heart were tried and were taken by the bass quite as greedily as had been the mullet. They could be purchased for less than a fourth the cost of mullet, at that time, and we became optimistic. We knew that hearts were fed at many of the Bureau's stations and that their mortality and costs as well were low.

Pig hearts were made our regular food, beginning July 1st, 1921. All seemed going well until spring. Then loss of adults became so high that on May 25th, 1922 the order for hearts was discontinued and a return made to mullet as fish food. Not only was the loss, under a heart diet, extremely high, but the output per adult was probably the lowest ever experienced here.

It may at times be advisable to cut off the artificial food altogether. In distributing our broodstock from the holding pond to the numerous spawning ponds, the past February, it was decided that the fish were too fat. All feeding was discontinued for six weeks. The results were satisfactory.

Probably all pond stations are troubled with algae. We have it too. Our scientific advisers tell us it is not to be

considered as wholly a curse but in part a great blessing. They say that, somewhat like weeds in a garden of vegetables, some of the great number of species of algae are the principal foods of the daphnids; which in turn feed our baby bass. They tell us further that the decomposing higher aquatic plants release the nitrates necessary for the growth of algae. These plants (algae) are seasonal in their appearance. Certain varieties, making their appearance in the winter months, are followed in rotation by spring, summer and autumn varieties. We know nothing of a method of promoting the growth of the good ones while at the same time checking the growth of those that are but a nuisance.

If nitrates, derived from decomposing plants in good fish ponds, promote the growth of useful algae, perhaps commercial nitrate of soda will give like results. It is our intention to make an applicaton of it to the bottom of our most barren pond, and then note results in algae, in minute animal life, and in fish production.

Every pond station has its own peculiar problems and only through experimenting at our own, checking results with those derived by similar experiments of others, is progress to be made.

Discussion.

MR. TITCOMB: That station was a political location, was it not?

MR. BULLOCK: The station was selected in this way. Congress provided for its location, with the restriction that the site must be donated. The whole state was scoured to find a site that would be donated. Many more desirable sites could have been gotten for a consideration; this was selected as the best to be had as a gift.

MR. TITCOMB: When you get something for nothing you do not usually get much. Would it not be better to abandon the station entirely?

MR. BULLOCK: Well, my idea is this: While the present conditions in our territory are permitted to continue; while station visitors can boast of taking bream from bream beds, in numbers, for a single day, in excess of our total broodstock, and others from 100 to 400 a day, I do not think the public is entitled to much more consideration or expenditure for their public streams; so the idea of abandoning this station and establishing another does not appeal to me very much. Moreover, we are fairly successful in supplying all applications. Our output is now sent out while fish are still in the advanced fry or No. 1 fingerling stage. In this way we get a satisfactory output; even though minute fish food is scarcer in our ponds than could be desired. I have said in the past, and I think the same opinion is probably held by a good many of you gentlemen here, that I would not exchange twenty-five two and a half inch fingerlings for a can of a thousand fry. I still adhere to the belief

that tne distribution of fry in flowing streams is of little value. But, when one party tells me that he found thousands of six and eight inch bass on the bottom of his broken pond in October, the result of stocking with fry in May, and others seem well satisfied with the number of twelve inch bass two years after planting fry, I am convinced that fry and small fingerlings are perfectly successful to plant in ponds. These, by hard work, we can produce in satisfactory numbers.

MR. FEARNOW: While this station is not located at an ideal place, it is performing a very useful work and, in spite of the difficulties that are being experienced there, we are producing a fairly good type of fish. A great percentage of the output is used for the stocking of private ponds, and in the southern states that often means the stocking of ponds owned by companies who employ large numbers of people, such as the Cotton Mill Ponds that we have in North and South Carolina and, I presume in Georgia as well. That matter was brought to my attention some time ago by a congressman from one of the southern states. He pointed out that these employees work long hours; that fishing is their only recreation and that they fish these ponds under restrictions. It seems to me, therefore, that the work being done at that station in very important in that it contributes to the happiness and comfort of the population.

MR. TITCOMB: I did not have it in mind that we should give up the fish culture work there, but I should like to give it up where it is not profitable. I should like to see the government buy a place where they could produce fish in maximum numbers at a minimum expense instead of spending so much money in a place where conditions are so unfavorable. The station is rather valuable for experimental purposes. May I inquire where you get your brood fish to replenish your loses?

MR. BULLOCK: The question of getting brood fish is our most bothersome problem. For a number of years they were purchased in South Georgia from the owner of a pond of between six and ten thousand acres. Last year we could not get them there, and we had five unstocked ponds. Prospects are very good for getting them for the next season at a very low unit cost. It is better to buy at a low unit cost, than to try to raise them. It may well be that they cost less than does the brood stock reared from fingerlings at some of the other stations. Aside from purchase of broodstock our operating expenses are kept low as we employ no temporary labor at our home station.

MR. WOODS: While we are on this subject, I may say that the Missouri State Fish Commission is represented here in the person of Mr. Kopplin, who has been in the Service for about thirty years. I think you ought to call upon him, Mr. Chairman.

DR. EMBODY: We shall be glad to hear from the representative of the Missouri Commission.

MR. KOPPLIN: I do not know that I have anything in particular to say, though I should be pleased to answer any questions. The problems involved are difficult, and each station will have to work out its own salvation. Now, the matter has been discussed pretty thoroughly, and

I shall not detain you, but if there is any information you want I shall do my best to furnish it.

MR. GEORGE BERG: We have had cases where trouble developed when the young fish reached about three-quarters of an inch. We term it "cotton-mouth," just among ourselves. The fish have a sort of growth in the mouth; it looks something like a fungus, and it affects them so seriously that they die off in large numbers. This year we lost something like fifteen or twenty thousand from that cause. The gentleman from New Jersey is the only one I know of who has also experienced it, and he does not know exactly what it is either.

MR. KOPPLIN: I have had experience along that line, and I attribute it to oil draining off our roads into the ponds. When we eliminate the oil we can eliminate the trouble.

MR. BERG: We have nothing of that sort. It might be due to something the fish eat.

DR. EMBODY: Am I correct in understanding, Mr. Bullock, that you spoke of there being as much as 60 parts per million of carbon dioxide?

MR. BULLOCK: That is what the state analysis gives.

DR. EMBODY: Did you have a statement of the percentage of free oxygen?

MR. BULLOCK: No. The analysis is taken from the State bulletins. The analysis is given therein of the waters of all the larger springs in the State of Georgia. The free oxygen in the water of our springs was not given.

MR. EMBODY: Sixty parts per million is so unusual that it seems almost like a miracle to me that any fish we have in this country could live in such waters.

MR. BULLOCK: That occurs at the spring. The water flows from there a few hundred feet to a stone crib; then it flows a few hundred feet to the ponds, falling out of the crib to the lower line of pipes with considerable splash—all tending to aerate it. But I am simply giving the figures to you as published.

DR. EMBODY: It is very interesting.

MR. TITCOMB: I should think that the Society for the Prevention of Cruelty to Animals ought to interfere when importing bass from wild waters to any such place as that.

DR. MOORE: The carbon dioxide might be well shaken out by aeration by the time the water reaches the ponds.

DR. EMBODY: I should think you would have a rather dense growth of green aquatic plants, which would eliminate it still more.

DR. EMBODY: Some of the members of the Society have asked for a symposium on foods and feeding of fishes. As I understand it, they desire a general discussion of what foods are used in the various hatcheries, what species of fish are fed, how the foods are prepared, what experimental work

is being done and what results have been obtained. The question of foods and feeding is a very important one; it has a direct bearing upon the health of the fishes in the hatcheries; if we do not give them properly balanced food, there is bound to be trouble sooner or later. It will be very interesting, therefore, to know what the practical men in the various hatcheries of the country are using as food and what success they are having in that direction. Mr. Titcomb, will you lead the discussion on this subject?

FOODS AND FEEDING OF FISHES.

MR. TITCOMB: The suggestion that this matter be discussed was the result of a conference among a number of fish culturists, and arose partly out of a conversation concerning our various difficulties and experiences. It would seem to be worth while that each of the practical men here who is engaged in fish cultural work should recount very briefly just what species of fish he is rearing what experiments he has tried what the results were, and what he is doing to-day as a result of his past experience. It was my idea that every man here who is engaged in that work could get up and briefly answer these questions.

I must confess that in this connection we have not done very much in Connecticut at the present time. We are, however, building up our work very rapidly. We are raising all our trout to at least three inches before distributing them. We had no hatchery where we could raise fingerlings. We have no large sources of water supply, so that in view of these conditions we are putting in what we call field stations or rearing stations, which are nothing more or less than a battery of hatching troughs set up as close as possible to the source of water supply. There are no flowers; there is no green grass growing round—just a feeding plant. We transfer the fry from the two hatcheries we now have to these troughs and there feed them until they are at least three inches long; then we distribute them until the last of them are about five inches long. There are some advantages in that method: we can keep the troughs perfectly clean; if our water supply turns out bad or if we have any disease we can put the whole plant on a truck and move it somewhere else. The largest one of these rearing plants has eighty-six troughs. We are feeding principally beef liver. We have fed shrimp with the liver this summer; we fed clabbered milk to some extent also in the case of the trout. I am not yet prepared to give the results of those experiments because this is our first season in the testing of that variety of food. We now have three of these field stations running and we are going to put up some more as rapidly as we find suitable water supplies.

I cannot contribute much on feed because you all have fed the beef liver. I prefer it to the livers of other animals, but I know that the cost is a little more. One other species of fish that we are attempt-

ing to feed at the present time is shad. We had an appropriation of $10,000 for studying the shad situation and a scientific staff has been working on that all summer. Dr. Moore was borrowed early in the season and gave us a great deal of assistance; we hope to have her again next spring. She can tell you about the natural food of the shad. We had some ponds in which shad were said to have been reared many years ago, and it happened that during the period that those ponds were stocked with shad the statistics of the commercial fisheries rose so rapidly that the commercial fishermen, now that shad fishery is about gone, keep harking back to what was done at that time. My experience in Washington and in New York had satisfied me, however, that any attempts to raise shad in ponds was doomed to failure. I was rather slow about going back to shad rearing in Connecticut, but we planted about 300,000 shad in a pond of about ten acres. They did very well, apparently, until they were about an inch and a half long. Shad caught in the rivers where they are spawning, the tributaries of the Connecticut and in the Connecticut River itself, are about twice that length, some of them four inches long. The last time we took specimens from this pond we found that they were going back; they were slim, weak and apparently starving; and we found that the particular species of plankton upon which they were known to feed were entirely exhausted. The first of last week we started in dragging for plankton in another lake with a view to transferring it to this pond in an attempt to save these fish. We are also feeding cracker crumbs, and we are using some dried shrimp, thinking that if they do not eat the shrimp they might eat some food developed by it. We have a scientist following up this work, taking specimens of young shad to see whether, for instance, they are eating crackers or whether they are eating the shrimp: it is an attempt to follow up this work of feeding shad through the season in order to see what the actual results from feeding are.

MR. HARE: At our station at Manchester, Iowa, one of the most complete tests in connection with feeding is being made at the present time that I have ever had any knowledge of. We have there a young man from the western biological station, working under the direction of Dr. Davis. I have never seen any man more devoted to his duties: he reports promptly at eight o'clock in the morning and never quits work until the evening. He has experimented with thirteen different sorts of food, and the tests made are very complete indeed. I am not in a position to state results, but when the next Convention meets a report will be submitted on that very subject, and I am confident that it will be one of the most complete reports on feeding experiments that we have ever had.

I want to add this: if there is anything that will beat hearts for trout, I would like someone to bring it to me. If you feed your beef hearts until the fish are seven weeks old and make a gradual change to sheep's liver, you will produce the goods. If we do not send out seven carloads of as fine fish as ever flipped a tail this year, I will eat my hat.

MR. CULLER: I have had some experience in trout work, and I agree with what Mr. Hare says about beef hearts and sheep's liver. I learned my fish culture under the grand old man of Rainbow trout culture, Mr. George A. Seagle of Wytheville, Virginia. He taught me that cleanliness was next to godliness and that the fish need exercise. His teaching was that if you kept everything clean and fed carefully, you could raise trout; and he certainly raised them.

DR. EMBODY: Have you had experience in feeding other fish besides trout?

MR. CULLER: We have fed bass down there; and have had no trouble whatever in feeding them with beef hearts; they took it the same as the trout would.

DR. EMBODY: How do you prepare it?

MR. CULLER: Cut it in strips to make it resemble angle worms. We feed sunfish the same way, and yellow perch. In fact, we never have any trouble in getting any species of warm water fishes to feed.

MR. TITCOMB: How do you cut it to make it look like angle worms?

MR. CULLER: Divide the heart and cut it in strings.

MR. TITCOMB: Using a sharp knife?

MR. CULLER: Yes.

MR. W. C. ADAMS: You are talking about adult fish?

MR. CULLER: Small fish, too.

MR. ADAMS: How small?

MR. CULLER: I have fed black bass four inches long.

MR. ADAMS: Small or large mouth, or both?

MR. CULLER: Both. It depends a great deal on the care the attendant gives the fish. If you get a man who wants to get through a job in a hurry you do not have much success, but a man who is faithful to his duty can soon teach the fish to feed. If necessary with your bass, put them in a small pond, a confined area; put a few trout that are feeding in with them and they will soon learn to take the food the same as the trout.

MR. BULLOCK: Black bass two inches long will soon learn to take artificial food of that kind.

MR. CULLER: I have fed No. 1 fingerling black bass in a trough, using ground up beef heart. I have fed bass three-quarters of an inch long.

MR. TITCOMB: In other words, you feed them what you give the trout.

MR. CULLER: Yes; we put the young trout in there to teach them to feed.

DR. EMBODY: Did you ever feed rock bass?

MR. CULLER: Yes. we did not keep the small mouth in the troughs. In the case of the large mouth, it was just an experiment to see whether they would take the food.

MR. FLEMING: And they took on an average growth?

MR. CULLER: Yes.

MR. ADAMS: An interesting experiment was made at one of our hatcheries this summer with the small mouth black bass which were somewhere between half and three-quarters of an inch long. These were bass fry that were sent out to one of our ponds; the superintendent of the hatchery took several hundred of them for the purpose of his experiment. He put them in a regular rearing pool and fed them with the ordinary stuff that would be fed to brook trout fingerlings say two inches long. The bass, however, gradually died off, the experiment never produced any green fish or any that were advanced in size. But it was rather interesting to see these little bass feed: they would go right down and, almost standing on their heads, would eat off the bottom. It was observed that the bass would go down and take the stuff off the bottom and feed on it, where the brook trout wanted it in the water where they could grab it. It seems to me that in this bass cultural work the question is to discover some food that you can feed to the small bass—I am talking now about small mouth black bass—that will supplement the natural food. I do not know how it is going to be done or whether we shall ever be able to do it, but it is the eternal struggle of trying to maintain enough animal life of the kinds that we have been working with in the past in our bass ponds, reducing what would seem to be the number of fish that ought to be raised in a bass pond, with intensive cultivation. The present foods will have to be supplemented, it seems to me, by something else if we are going to carry on this work on a big scale.

MR. HARE: Mr. Culler brought out a point that is far more important than might be imagined, and that is that you want to give your young trout something to do; you want to set them to work. There is a simple way of doing that. I do not claim any credit for it; it is not my own idea; I did not originate it. But in our troughs at the Manchester station we use what we call division dams. The division dam is nothing more than a piece of sheet metal across the trough; the water cannot flow over the top of this dam but does flow underneath, and in that way we have a strong current at three or four different positions in the troughs, and you will always find the young trout right in next to this division dam. They are always working against that current, which is perfectly natural for the trout, and that has a great deal to do with keeping them in a healthy condition. I just wanted to emphasize that point brought out by Mr. Culler; it is really important.

MR. CULLER: I can tell you where that idea came from: it is one of Mr. Seagle's inventions.

MR. HARE: He deserves great credit for it. It has worked wonders for me.

MR. CULLER: About 1905, under Mr. Titcomb's direction, Mr. Seagle conducted a series of experiments in connnection with which we tried all the different kinds of food that were known at that time. In addition, we tried an aquatic bug from Mexico—cooked, ground up and dried. We tried azotine and meal, and liver and meal.

MR. BULLOCK: What you refer to as azotine is called "fishotine" now?

MR. CULLER: It is the same thing. Well, do not feed that to your fish until after they have reached two and a half or three inches, or you will have mighty disastrous results. The digestive organs of the small fish cannot take care of azotine.

MR. BULLOCK: We feed it to bream when they are along about three inches.

MR. CULLER: I have had experience in connection with trout, and find that the feeding of azotine to the small ones brings about disastrous results.

MR. BRUNSON: I have fed everything that it is possible to prepare for fish food—all kinds of dry food, mild cured food, smoked food, and so on, and of all the foods I know I have always had the best results with salmon carcasses, mild cured and freshened in running water—allowed to stand in running water twenty-four hours, then ground through one of those special plates we all use in the fish hatcheries. Put it through that plate from ten to fourteen times; then take beef spleen, prepare that in the same manner, and mix one spoonful of beef spleen to three spoonfuls of salmon carcass. If that is fed through a shaker it will come out resembling little angle worms; the size of the holes in the bottom of the shaker would depend upon the size of the fish you were feeding. I feed them that from daylight till dark. Then, I feed one feed daily consisting of a mixture of some cereal with spleen. We used to call that "cereal middlings"; it was mixed with raw beef spleen. With brook trout we would use cooked beef liver and cooked spleen, although the raw spleen and the raw liver is best. In Montana on brook trout and rainbow and native trout at present we use beef liver, hog liver, sheep liver, beef hearts, sheep hearts, fish carcasses—anything we can get, mixing it fifty fifty with cereal and feeding twenty times a day. Mr. Culler has seen some of my fish, and he can tell you whether or not I am getting results.

MR. TITCOMB: You are feeding twenty times a day?

MR. BRUNSON: Yes. I cannot feed more than that because I have not the money to hire the men.

DR. EMBODY: These are your young fish, when they are first beginning to feed?

MR. BRUNSON: I hatch my brook trout out in September and in December they get it, and they get it twenty times a day too. I think the whole success in feeding is in the preparation of the food. If you can get your food fine enough so that your fish can digest it fast enough, you will get the quick growth that is so desirable.

MR. YOUNG: A company at Put-In-Bay have been turning out a food which is ninety per cent fish—lake herrings— and the rest cereal. I was sent some samples of this food. The fish is cooked, ground very fine and mixed in with the cereal, and it is claimed to produce wonderfully successful results. This food in its finished form is in fine particles

which go to the bottom, and the bigger fish do not pick them up, but the fish will devour it ravenously if you can get it to them before it hits the bottom. I believe the name of the manufacturer in Put-in-Bay is Paxton. The cost of the food is six cents a pound.

DR. EMBODY: It is a mixture of fish and cereals?

MR. YOUNG: Yes. It is from seventy to ninety per cent fish.

MR. FOSTER: The Paxton food has not proved as good for the small fingerlings as beef heart.

MR. TITCOMB: Is it good for the fish after they get started?

MR. FOSTER: It has not been definitely tried out. As far as I know there have been no conclusive experiments on the larger fingerlings.

DR. EMBODY: Have you used it alone without any fresh meat like liver or melts?

MR. FOSTER: Yes, alone and with combinations.

DR. EMBODY: I imagined that if you used dry food alone—

MR. FOSTER: It is not very dry. It is a mush preparation.

DR. EMBODY: Is it bought in that form?

MR. FOSTER: Yes, it comes in a paraffin sack.

MR. BRUNSON: Mr. Titcomb mentioned the use of dried shrimp for fish food. We have used dried shrimp, tried it in every conceivable manner, but it seemed to kill the fish that ate it. I would like to ask the members of the society if anyone present knows whether dried food does not always swell after the fish eats it, with the result that there are internal injuries which may cause death.

MR. TITCOMB: We boil the shrimp before we grind it. Moreover it comprises only one-quarter of the food; we feed liver three times where we feed shrimp once.

MR. BULLER: I have been experimenting so many years with fish food that some of the early experiments we have made in Pennsylvania have been forgotten. I shall deal only with what we have found best in the hatcheries of Pennsylvania and what we are using to-day. We are propagating quite a number of different species of fish and rearing them before they are placed into our streams. It is absolutely necessary, if we want any results at all, to raise our trout up to at least nine months; we never plant any trout in the waters of Pennsylvania which are less than nine months of age—from that on up to two years. Now, in order to grow these trout and to grow them in numbers we have made different experiments with a few trout under favorable circumstances and have obtained results which we could not duplicate when we tried to do the same thing in connection with the growing of trout by the hundreds of thousands or millions; and invariably we have come back to our old friend the sheep pluck as our principal food. The first feeding is the ground sheep liver. We find in our hatcheries that that gives the best results in the rearing of the fry, with the addition of milk curd. We feed that to our trout in the fry stage, or up until they reach a size of from two to three inches. Milk curd is a very good combination with sheep liver.

MR. TITCOMB: How do you mix it?

MR. BULLER: In the early stage of the fry it is mixed with the liver, but as the fry advance we feed it at night; that is, the fish are fed constantly all they will take. We have men who do nothing else but feed; that is their business. Our aim is to keep our fish as full as possible, keep them growing as fast as possible. The last food that man gives is milk curd; that is put into the troughs in the evening and by morning it has disappeared; there is never any of it left. As these fish grow in size, the combination then is the liver and heart and lung ground together.

MR. ADAMS: At what lengths do you begin to feed the complete pluck?

MR. BULLER: From two to three inches.

MR. TITCOMB: Do you feed clabbered milk to the larger fish?

MR. BULLER: Not to any considerable extent. We do occasionally in the ponds, but in the fry stage and up until they are two or three inches long we think it is a very beneficial food along with the sheep pluck. As a result of long years of study we find that that food is giving the best satisfaction with our trout, and we are sticking to it. As I mentioned this morning we have started feeding shrimp. I am not condemning shrimp at all—I hope I am mistaken in regard to it; further studies would seem to be necessary on that phase of the subject. Every fish culturist admires the beautiful colors of the trout which we are not able to produce with this artificial food. In order to produce these beautiful colors I conceived the idea of feeding the trout with shrimp. I refer to trout that we were keeping for exhibition purposes; in fact, that is the only purpose for which we keep any adult trout, with the exception of brown trout. Well, in the pond where we fed the shrimp, the trout practically all died. We intend, however, to carry that experiment a little further; it may not have been the shrimp that caused the trouble in that particular pond.

With regard to the feeding of bass, I suppose Pennsylvania has spent as much money as any State in the Union on the rearing of small mouth black bass. That is the fish that the sportsmen are insisting upon having, though we are trying to convince them that it is absolutely impossible to grow and rear them in any considerable quantities. At least, I have never found any station yet that has grown small mouth black bass in large numbers up to a size of four or five inches. We have tried all kinds of ponds; we have tried all kinds of foods, and we have not been very successful with any of them. But we have not given up, though we might have if we had not been fortunate enough to get the resident fishermen's license, which has given us some money to carry out further experiments with the small mouth black bass.

I would like to give you the benefit of some of the experiences of some of the men in Pennsylvania in regard to the black bass. Some years we raise some, other years we do not. We have one pond that comprises an area of about half an acre, the depth of the water being

from eight feet to two or three inches. We have never in all our experience been able to retain small mouth black bass in any of our ponds that would reproduce on artificial food; that is, when the time came for the spawning of the eggs, invariably the bass were in such condition that the eggs were never normal. So that we depend every year on a new supply of breeders. We have tried all sorts of artificial food without any results that could be considered worth while. Well in this pond to which I referred, we introduced one year 100,000 small mouth black bass fry.

MR. ADAMS: Where did you get them?

MR. BULLER: Took them off their nests. The water conditions were very favorable; we had plenty of plant life in the pond, an ample supply of Daphnia for the fry when they were in the small stage. We attempted to feed them artificially, and in October, when we drew that pond down, we had one black bass nine inches long; he was the only one there. What happened I am at a loss to explain; I am just telling you about some of our experiments. In that same pond next year we put about the same number of small fry and fed them with minnows which we gathered daily from some of the storage lakes to which we have access—we brought in from fifty to one hundred cans of small minnows every day— and in October that year when we drew down that pond we took out 49,000 bass from four to five inches long.

MR. ADAMS: The pond being of the same size?

MR. BULLER: It was the same pond. We have come to the conclusion, therefore, that what work we do in future with the small-mouth black bass will be done with live minnows, and with that end in view we have now a pond on which work is proceeding—it will be completed in four or five weeks—that will cover an area of from 95 to 125 acres, and there we propose to carry on the rearing of small mouth black bass with minnows. We have never been successful in doing it in small ponds, and it is my opinion that anyone who wishes to continue the rearing of small mouth black bass will have to use live food. I am not speaking of hatching out small mouth bass and distributing them in the fry stage, because our people will not accept them under those conditions; we must raise the fish up until they are suitable to put into the waters.

MR. ADAMS: The small mouth bass in that lake are of what size?

MR. BULLER: Four, five or six inches in October; some three and a half.

MR. TITCOMB: At what time will you begin to introduce minnows in this pond?

MR. BULLER: As soon as the bass are three or four inches long.

MR. TITCOMB: What size minnow will you use?

MR. BULLER: Very small; we get them by the hundreds of thousands now. Anybody who goes in for the propagating of bass must realize that it is going to cost them money. It costs us a great deal; we have to produce these minnows, we have to raise them; we have to have places to do that, and it is going to cost us money. But that is

what the sportsmen expect us to do, and we are spending their money. They are perfectly satisfied that we do spend it in that direction provided that we show them some results for the expenditure.

Other species of fish that we are propagating and rearing are the yellow perch, the bluegill, and the catfish—that is the bullhead.

MR. ADAMS: Before you leave the question of the bass, what do you think of the plan—leaving out the wishes of the fishermen of Pennsylvania—of collecting up in ponds that have a liberal supply of bass, the fry that are say half an inch long, and planting them in other ponds?

MR. BULLER: If you can get them half an inch and over I think it would repay you.

MR. ADAMS: Do you think that in the long run that would be as profitable as to carry on the usual bass culture work that has taken place in many States?

MR. BULLER: Of course, bass culture work is very expensive, and I am putting that before the Pennsylvania sportsmen as strongly as I can. We have a mailing list in our office of 560 Fish and Game Associations in Pennsylvania with which I am closely in touch all the time. I am frequently called upon to talk to these people and I try to impress it upon them that the artificial propagation of bass is a very expensive and a very difficult thing and that they need not expect, at least for some years to come, that the State of Pennsylvania will be able to distribute small mouth bass in the quantities that they distribute other fishes. I have impressed upon them the fact that bass fishing is increasing, in spite of the great number of fishermen, in our streams that are suitable for bass, but I attribute that to the season that we have on the bass more than to any restocking of the streams. We positively refuse to plant any bass in any small lake in Pennsylvania, because in every case where either the small mouth or the large mouth bass has been introduced into the lakes of our State the rest of the fishes having been destroyed. Our small lakes are not suited to the bass. They are all on top of the mountains; the water is absolutely pure—they are what we call "hell holes"—no visible inlet to any of them.

MR. HART: What kind of minnows do you feed these bass on? How do you raise them, and what does it cost?

MR. BULLER: What we raise in our ponds at the hatchery are the banded or striped minnows. Most of the minnows that are fed to these bass are taken from such lakes as are in close proximity to the hatchery. These are principally the little shiner—golden and silver.

MR. BURNHAM: Do you get the best results from small mouth black bass breeders collected in the spring, or from those collected in the fall?

MR. BULLER: The collection in the fall is the safest. We have occasionally in the spring of the year received our bass too late. If it is possible to get them in the fall and you have the proper storage for them, I think it is best.

MR. HARE: In speaking of trout, did you speak of planting them in the advanced fingerling stage?

MR. BULLER: We do not call them fingerlings. We plant nothing under nine months.

MR. HARE: I want to ask you one of the most pertinent questions one man can ask another in regard to fish culture. How do you arrive at the conclusion as to the relative worth of trout fry and trout fingerlings?

MR. BULLER: That is a different subject.

MR. HARE: If you will answer it we will crown you lord of all.

MR. BULLER: I may say that we in Pennsylvania have probably more difficult problems to work out than any other State. We have for many years been planting fry without any results. We are increasing and improving our trout fishing in spite of the many adverse conditions that we have to meet, and it is done only by rearing trout until they are a catchable size before they are put into the streams. I know that there is a large hatchery on the Lackawaxen River, on the banks of which I live; and you can put 10,000 fry into that stream and a month afterwards you can search for trout without success. I know every nook and hole and ripple in that stream, and I will give you fifty cents for every trout you find there resulting from that planting. In this same stream I have gone out in the morning and in half an hour come back with from seven to nine trout twelve to sixteen inches in length, any time I wanted to do it.

MR. CULLER: Have you had any experience in planting eyed trout eggs?

MR. TITCOMB: I rise to a point of order.

DR. EMBODY: We have a paper on that subject; would it not be well to defer any discussion until that paper is presented? Let us confine our attention this afternoon to the matter of fish food.

MR. BULLER: We have our trout fishermen, who believe in the elimination of every other fish in our waters except trout, and who think we should devote all our time and attention to the propagation and rearing of trout. Then, we have the small mouth black bass man who takes the same position in regard to the bass. We have another class of fishermen, a class which outnumbers either the advocates of the trout or the advocates of the bass, made up of people who love to catch yellow perch, catfish, bluegills, suckers, and fish of that kind. We are therefore devoting a lot of time, energy and money to the propagation and raising of these various fishes. We find that the most profitable of the catfish in our waters is the common bullhead. We are rearing these in great numbers and growing them until they reach a size of two and a half to four inches with very good results.

MR. ADAMS: With regard to your bullhead fry, will you tell us how you get them, how you feed them and bring them to that size in the fall?

MR. BULLER: We have our bullhead breeding ponds as we call them, we bring in our breeders in the fall of the year from the storage lakes to which I have referred, and put them into the pond. The young catfish are taken up into the rearing ponds and there they are fed until October.

MR. TITCOMB: What is the size of the breeding pond?

MR. BULLER: About half an acre. In addition we also go on to the storage dams and collect hundreds of thousands of catfish of the size that you would get out of the rearing ponds. We only keep our rearing ponds to guard against any unfavorable circumstance which would prevent us gathering the fish at the proper time; thus we make sure of a supply of young fish. These young fish are fed sheep liver and milk; they are voracious feeders and grow rapidly on that kind of food. We have never experimented with or tried any other food, but we will probably do so when we get around to it. However, we are getting very good results from the sheep liver and the milk.

MR. TITCOMB: You mean clabbered, soured milk?

MR. BULLER: Yes.

MR. ADAMS: When you collect your fry either from outside or from your central producing pond where you have your adult stock, how much of a body of water do you put them in to rear them?

MR. BULLER: Our ponds run from a quarter to half an acre each.

MR. ADAMS: How do you feed milk to these fish in bodies of water that size?

MR. BULLER: We put it around the shores and at the inlets. At feeding time they will come to the troughs like a lot of bugs, and they take a great deal of food.

MR. ADAMS: The first feedings are these feedings of clabbered milk?

MR. BULLER: Clabbered milk and liver.

MR. ADAMS: You start right off with the liver as well as the milk?

MR. BULLER: Yes.

MR. ADAMS: Do you feed the two at once, or do you give the liver during the day and follow at night with the milk, as in the case of trout?

MR. BULLER: We feed all our milk at night. Of course, we endeavor to have as much aquatic life in our ponds as possible. We never disturb any of these ponds with a net. Before the ponds were arranged as they are at present and the fish were taken out with a net, the result was destruction of a good deal of aquatic life in the ponds. They are now so built, however, that we draw out our fish.

MR. ADAMS: How often during the day do you feed the small fish?

MR. BULLER: They are fed morning, afternoon and evening. They are practically feeding all the time.

MR. ADAMS: Ground up liver about the size you would feed to your small trout?

MR. BULLER: Yes, very fine when you start, because they are small.

MR. ADAMS: You feed them on shore?

MR. BULLER: On shore and at the inlets too.

MR. ADAMS: In the case of the bluegills, do you separate your fry from your adult stock?

MR. BULLER: No, we have our bluegills all in one place. We do not separate the fry from the adults; we have not got to the point where our room will allow that. Arrangements are now under way, however, by which our present plant will be increased to the extent of about forty per cent.

MR. ADAMS: Would you think it practicable to catch up the fry from the larger ponds where you have your bluegills now stocked and transfer them to the rearing stations as you would the hornpout?

MR. BULLER: Yes, I think so. We would be doing it now if we could.

MR. ADAMS: And you would feed the bluegills about the same way you feed your horn pout—start them off with the clabbered milk and then go on with the liver?

MR. BULLER: Yes.

MR. FLEMING: How many will you rear in one pond?

MR. BULLER: The number varies. In the quarter acre and half acre ponds we have anywhere from 80,000 to 300,000 fish. Some years we are more successful than others.

MR. TITCOMB: The average being about three inches?

MR. BULLER: Two and a half to three inches.

MR. ADAMS: You plant these small bluegills in the fall?

MR. BULLER: Yes.

MR. TITCOMB: Can you raise as many bluegills in that pond as you can bullheads?

MR. BULLER: No. It requires more water for the bluegills than it does for the catfish. You cannot grow them as you can the catfish.

MR. TITCOMB: Is there much cannibalism among the bluegills?

MR. BULLER: We do not notice it. I do not believe there is.

MR. ADAMS: Could you, at a given pond that houses, we will say, the maximum number of brood stock in the spring, produce the maximum number of young bluegills which that pond is capable of handling?

MR. BULLER: If the adults were not in there, no.

MR. ADAMS: In other words, you could supplement the stock which you got from your adult fish by bringing in stock from the outside as well.

MR. BULLER: Yes, indeed.

MR. BURNHAM: Do your bluegills continue spawning all through the summer?

MR. BULLER: Yes. They are one of the long season fishes. What we intend to do when the program is complete is to take these ponds that contain the adult bluegills and the young fish, draw them out and then retain the young fish until next October; they will then be a year old before we let them go off the property. We believe that is the right method to pursue, and that it will bring better results than we can

get by planting in October. There is a variation in the size of the bluegills on account of the early and late spawning.

MR. HART: Is the butter fat taken out of the milk before it is soured?

MR. BULLER: Oh yes, it is skim milk. We have milk separating stations in close proximity to the plant from which we can buy all we want. We are paying twenty-five cents for a forty quart can of that milk, so it is a rather economical food.

MR. FLEMING: In your small ponds which, as you say, have a capacity of from 80,000 to 300,000, what growth do your bluegills take on the first season?

MR. BULLER: Sometimes they will be an inch and a quarter long, and sometimes not more than half an inch. That is why, when this plan is completed, these fish will be held over next year so that we shall have bluegills which are two, three and four inches long.

MR. FLEMING: I am raising bluegills, and I use no artificial food whatever. In one of our ponds which is about the size you speak of, the fish are as small as three-quarters of an inch, and I was wondering whether artificial feeding produced better growth, or whether it did not.

MR. BULLER: We have to feed in our ponds; we would not have anything if we did not.

MR. WOODS: Did you ever try it without feeding?

MR. BULLER: Yes.

MR. FOSTER: Did you ever try feeding clabbered milk in a skimmer —just shake it in the water?

MR. BULLER: Yes, but that is too slow a process.

MR. FOSTER: We found that we fed the fish on the milk they did just about as well as when fed on beef hearts and sheeps liver. Those fed on beef hearts went a little ahead of those fed on the sheep liver and milk, and those given two feeds of milk with three feeds of beef hearts did as well as any.

MR. BULLER: We advocate the use of milk. We find it keeps our fish in a healthy condition, fed in conjunction with some concentrated meat foods.

MR. TITCOMB: You separate the young of this year from your adults this fall; you put the young in a pond by themselves?

MR. BULLER: For shipping.

MR. ADAMS: Are you doing anything now with the channel cat or any of the catfishes other than the horn pout?

MR. BULLER: I did have some channel cat, but we could not get them to feed; they would not take live food or anything else, with the result that fish which were a foot long when we got them were about like my finger when we released them. We could not get them to feed in the aquaria, either, I do not know why.

MR. TITCOMB: Let us hear from Mr. Hayford.

MR. HAYFORD: In the course of five years we did a great many things in regard to the rearing of bass, and the results were somewhat

discouraging. However, about three years ago, after Dr. Embody had been with us about two weeks, we began to get tangible results. We got them in this way: we started spending money—as Commissioner Buller says, it is an expensive proposition. The first thing we did was to dam up our water supply, or get it under control: by means of a ten inch pipe a supply of pond or brook water which has been held back is forced round into another pond of about three acres which is on a lower level. I may say that probably few fish culturists have exactly the same conditions as we have. Our ponds are mostly built by the use of horses and scrapers, and our water fall is nineteen feet on our own property in a distance of 3,000. That permits us to get good drainage. We also have limestone water, in which most of the aquatic plants grow profusely. After many troubles we have succeeded in hatching the fry, and we get Daphnia and other minute organisms in sufficient numbers to feed the small fish until they are three-quarters of an inch to an inch long. We found that when we got to that stage we were up against it; and Dr. Embody suggested that we should try to raise mosquito larvae. That would seem to be a big problem, but it is not as big as it appears to be; the only thing is that you have to careful with the adult mosquitos so that they do not get away from you, because you must retain the friendship of your neighbors. We have overcome that by taking the mosquito larvae and spreading them over ponds. These bass soon became very tame, almost like trout. Then, as they grew larger we substituted maggots—we can produce these, of course, in almost any quantity. But the bass would not eat maggot as it dropped from the fish waste, or whatever we wished to use, direct into the receptacles; we had to let them drop into chopped straw and bran and wiggle down through. When we did not adopt this plan the fish would take the maggots in their mouths and then blow them out, but with the use of the straw and bran they would not do that. Well, we took them from an inch to an inch and a half on mosquito larvae and we got them from an inch and a half to two inches and a half very nicely with the maggots; then, of course, cool weather began to set in. We then tried clam meal and shrimp from Louisiana, but that alone would not bring about the desired result. We found that by getting a greater density of plant life we could produce large quantities of shrimp and crustacea there, and by supplementing these two foods with such amount of clam and maggots as they would eat, we could get them from the two and a half inch period up to the four inch period by October. We have not yet done this on a large scale; and that brings us back to Commmissioner Buller's statement that when you get to working on a larger scale you have to have quicker methods. Our piping system is such that we can drain the ponds containing these larvae direct into the supply pipe; we build our ponds generally on a higher level so that we can open a valve in each one and blow this stuff into them in order to add to the food that is already there. When we have food

enough, we do not disturb these two stock ponds very much ; we let the water take its natural course around through the chain.

We have reached the point now where we have less trouble in feeding the small mouth than we have with the large mouth. The small mouth bass take the food more readily and become tame more quickly. But we do have less trouble in the reproduction of the large mouth than we have with the small mouth; therefore, each one seems to have its own trouble. I find I can do much better with the small mouth bass, under our conditions in New Jersey, in small ponds about one-third of an acre, while with large mouth I can do better if I put them into ponds from two to three acres and let them come up to a point where they are, say, two and a half inches long. Then we draw the pond off and grade the bass according to size, whereupon they are put into smaller ponds that have the weeds in them.

MR. TITCOMB: Do you feed the large mouth?

MR. HAYFORD: Yes, we feed the large mouth too. We have always worked on the plan of using the small minnow. We have one pond there now that contains probably 2,000 large mouth bass fingerlings from four to four and a half inches long, and we are able to get enough small minnows to meet their needs. Last year we had some small mouth bass in this pond, and I can see no difference so far as growth, etc., is concerned. We expect to build from twelve to fifteen ponds from time to time as we need them and as funds permit, to raise forage. We believe, from experiments, that we are going to get a great deal in the way of results from raising small goldfish, and it might be that we could raise small carp; in fact, I think each one has to work out his own problems; conditions respecting water, and so on, are so different in different places. When I first started, if I could get from 500 to 1,000 bass to grow, I felt pretty big. That result, however, is no longer satisfactory; in three different ponds this year we were able to get out from 16,000 to 24,000 per acre of fingerlings from two to four inches long. We have four large ponds there, and we always have had three experimental ponds.

Our department is only building as fast as we can show results. We have been getting results from the reservoirs. This spring we took out quite a few fry from the reservoirs as they came to the surface—helpless, you might say—and transferred them into inexpensive ponds which contained myriads of Daphnia. These bass grew very rapidly up to an inch; of course, we could not go further than that, because we had others in the ponds that we had put our breeders in. I may say that in one pond where we had approximately 20,000 small mouth No.1 fingerlings, the fish became badly affected by fungus. The first signs were spots here and there around the head; it was what we termed "pin point" fungus—a little spot here and there which gradually merged into one large spot. Therefore I think we have to be careful in bringing the small fish in from the reservoirs. These fish were brought in at night, and I asked the fellow who brought them in whether he noticed

anything the matter with them, and he said. "Oh no, nothing particular; it was dark but you could see little things on them, I suppose it was clay stuff or something like that." But we had none of that in the ponds this year that we hatched in. It has occurred in other ponds which were newer, though: we have a clay formation on the bottom of the pond and it takes from two to three years to get a suitable amount of black muck and scum through the decomposition of plant life which will in turn enable the ponds to grow plant life profusely.

In conclusion, as I have said, I think that every fish culturist has to work out his own salvation, but he cannot do it without the assistance of the scientific man, who can carry out experiments, examine stomachs, apply his biological knowledge and training—something which, unfortunately, a great many fish culturists do not have. May I say also that for whatever success we have attained the credit is due not so much to me as it is to Dr. Embody.

MR. BEARD: I am not a fish culturist, but I am a chemist. Mr. Buller stated that he could raise small mouth black bass; one year they fed them artificially and had no success; the next year they fed them minnows and raised a large number. Now, these fish that grew on minnows must have been furnished with certain food factors such as are given to sick people, and so on, in order to get results. They must have been furnished with such things as protein, different food constituents, vitamines, and so on. Might it not be a good thing to study what the requirements of the fish are from a biological standpoint; to find out what they should have in the way of food constituents? It seems to me that if that were done you would have some basis to work upon in connection with the things you do. That is, instead of feeding this, that and the other thing, irrespective of whether or not you are giving them the proper food elements, it seems to me that here is a field that might profitably be gone into through study and investigation. Wonderful things have been done in that same line in connection with the food of human beings.

MR. HAYFORD: Quite so; that is why we carry on a great deal of our work along these lines.

MR. BEARD: My idea would be to get the right type of man to correlate all these different facts so that proper scientific conclusions could be arrived at with a view to getting definite results. There would certainly seem to be opportunities along that line. Furthermore, if we got down to the bioligical and chemical fundamentals, the food constituents necessary in certain cases and at different stages, we might be able to devise foods that would be not only better but cheaper, and a large amount of money would thus be saved. We may be now paying ten cents a pound for fish food which is not perfectly suitable, whereas inquiry might result in the production of a food that could be turned out at say $15 a ton. The thing is to know exactly what kind of food you want to make.

MR. HAYFORD: I have been writing during the last month to various canners and people who put up fish, and I have obtained a great many samples. It is in the analysis of these various foods that the chemist has to play an invaluable part. I do not think it is in any sense a one-man problem: you have to have the practical fish culturist, the chemist, the biologist and the pathologist. As an example of what some of these foods cost, we pay three and a half cents a pound for one type of food delivered at the station, which means an expenditure of $9,000 a year for food alone at that one station. Where the fish culturist has twelve or fifteen men, 160 pounds is about all he can handle if he wants to keep things humming. That is where he needs the scientist to help him. Our Department is going to let me have the services of Dr. Embody from time to time, as he can be spared; the present program is that he shall be with us four or five days in every sixty in order that he may check us up. Then when he can spend a longer period with us he can go into these various matters further. One of the commissioners asked me if I would like a couple of thousand dollars to spend next year for investigational purposes, and I told him, no; that by putting the problem up to Dr. Embody we might have attention given to some of the vital points and might have him start right off in the direction of the work, thus avoiding any delay of a year or so in waiting for results in the larger field. I suggested recently that it might be a good thing if we could all submit our problems to a committee of three, consisting, say of two scientific men and one practical man, with the understanding that the knowledge imparted to him would be treated as confidential; then each year we might have considerable progress to report in connection with these various problems. We are doing certain work in New Jersey; other States are going into these various matters; there is a good deal of duplication of work. If these problems were put through such a clearing house of scientific men and boiled down to something definite, I am quite sure we would get somewhere. In order to raise fish in large numbers, a great deal of fish food must be purchased, and that costs money. We probably use 150 tons of food a year. I will mention one thing we do which results in a little more economy in the use of foods. We have one mixture in connection with which we use this by-product of shrimp; if we did not use shrimp with a certain number of the fish we would average twenty-eight pails of twenty-five pounds each, but by putting in certain quantities of the shrimp we bring that figure down to twenty pails. The feeding of shrimp, etc., seems to do one thing especially—it stops nipping. It has been my experience that when fish start nipping at one another their systems are out of order, and the administering of a wider variety of foods seems to eliminate that condition and to make them more peaceable.

MR. BEARD: A great deal of money is spent in more or less indefinite experimentation, trying this, that and the other thing; and it does cost money. If that money by some miracle, could be all taken together and turned over to the right source, say the Bureau of Fisheries, and the

right type of man assigned the task of correlating all the facts and working down to fundamentals, I believe that very definite results could be produced. Take the different results obtained through the use of shrimp meal: of course, no two shrimp meals would be alike. For instance, one might have been scorched; undoubtedly some vitamines may have been destroyed in the process, so that different effects would be produced in different cases. If, therefore, you could hit upon a shrimp meal of the right type, your feeding problem would be largely solved. The same would be true in a large measure of fish meal. I happened to be talking to a fish meal producer in California; I do not know how much truth there is in what he says or to what extent his reasoning is on a scientific basis, but he produces a fish meal that is much better than any other produced in that part of the country. He produces it in non-reducing atmosphere where the oxygen has very little effect upon the meal in its production, and he produces a meal that is not in the least degree scorched. He uses very fresh fish, and he claims that when fed to dairy cows reactions are obtained which could not be brought about by the use of the ordinary fish meal. Now, the vitamine content of that meal, taken in connection with other accessory food factors, must have some bearing on the reactions that they get in these cows, and it is quite possible that all these things would have a very direct bearing on the feeding of the fish if they could be brought to the stage where they are definitely known and understood.

MR. TITCOMB: The object of this whole symposium is to bring together the experiences of all the fish culturists, and it is my suggestion that the man who is called on to give his little story on the subject should be allowed to give the whole of it; then that he should be questioned on it; then that somebody else should go on in the same way. I would like to ask Mr. Hayford to continue what he was saying about the feeding of shrimp, and to ask him what results he has had in that connection.

MR. HAYFORD: We are feeding shrimp to the brook, brown and rainbow trout—that is the big end of it. We have not been able to get the shrimp in sufficient quantities to be able to feed more than ten or fifteen per cent. Our present ration is eighty-five pounds of sheep's plucks—the heart, liver and lungs of sheep—and fifteen pounds of shrimp. That produced very good results with us last year.

MR. TITCOMB: Do you boil the shrimp before you grind it?

MR. HAYFORD: No, we simply soak it in cold water to get rid of the swelling. In order to do this work as we wanted to do it we bought an International No. 6 Type "B" Feed Mill, such as the farmers use for grinding grain. You can put the clam or the shrimp or most any of these products into that and grind it almost to a dust if you want to. We grind the plucks and the whole thing together, after the meal is added, spread it right out on the floor, take an ordinary scoop shovel and shovel it right into this hopper.

MR. TITCOMB: Do you raise other warm water fishes than bass?

MR. HAYFORD: We have raised some perch and this year we tried bluegills, but principally it has been the five species, rainbow, brook and brown trout and large and small mouth bass.

MR. TITCOMB: What do you feed to the bluegills?

MR. HAYFORD: Clam meal. The small mouth adult bass also eat it ravenously. To the large mouth bass we give sheep's plucks; we cannot get them to eat the clam meal. We turn that out a little larger; it comes out the size of a pencil.

MR. TITCOMB: Can you get plenty of clam meal?

MR. HAYFORD: We can get enough for our purposes—two or three tons a year. Last year I think we got two tons.

MR. TITCOMB: Do you think they eat the clam meal entirely?

MR. HAYFORD: They eat it; they sit around waiting for it, you might say. When you go down in the morning at ten o'clock to feed them, they are all there waiting for it like a lot of hungry boys.

MR. TITCOMB: Do you raise bullheads?

MR. HAYFORD: No, not to speak of. We have not any ponds for that purpose as yet.

MR. TITCOMB: How do you produce the mosquito larvae?

MR. HAYFORD: We put sour milk into concrete tanks five by thirty. The mosquitos seem to fly up from all over the sections, and next morning the place is all covered with mosquito eggs.

MR. TITCOMB: Do the bass consume all the larvae you put in?

MR. HAYFORD: Mosquito larvae to bass are like candy to a child. The reason we went into this mosquito larvae question arose out of a paper given at Allentown, Pa., by Dr. Embody. We also have a lot of the shrimp in our ponds; it is not the little fellow or the big one; it is one of medium size. What is the name of the shrimp we have there at Hackettstown, Dr. Embody?

DR. EMBODY: I think it is the Caledonia shrimp; if not that, it is one very closely related to it.

MR. HAYFORD: In the case of the large mouth bass, if we put minnows in with the sheep's hearts we always get a good fat fish.

MR. TITCOMB: Do you raise minnows for food?

MR. HAYFORD: We have not made a business of raising minnows. I may say that one year I put about fifteen thousand fry into a pond 50 feet wide by 160 feet long and from 2 to 3 feet deep. I put them in on the 15th of June, and on the 16th of September we took out 5,702 fingerling small mouth bass from one to three inches long. It may be said also that there does not seem to be much loss up to the three-quarter inch and one inch period; it is from there on that the loss occurs.

MR. TITCOMB: Do you find any particular kind of minnow preferable to others?

MR. HAYFORD: What we have is largely the golden shiner. The desirable thing, of course, is a slow moving fish; some of them move too fast.

MR. DOZE: Do you raise any carp?

MR. HAYFORD: No—I have to be careful how I say "carp". But I believe it would be a good thing to do.

MR. CANFIELD: Have you ever tried the orange spotted sunfish?

MR. HAYFORD: No, not to any considerable extent. We have them in this plant, but only in small number. It does not seem to make any difference with these young bass how long a minnow has been dead: we can take four or five cans, go up to the pond, and dump them in; and if you go round the pond in an hour you wont even see a dead one.

MR. CANFIELD: Do you find it cheaper to collect your minnows than to raise them?

MR. HAYFORD: These ponds are on our own property.

MR. CANFIELD: In other words, the labor in collecting them is less than it would be in raising them?

MR. HAYFORD: Yes. The big cost is building—that is where the pinch comes.

MR. DOZE: Have you the leaf hopper out there—a little green bug?

MR. HAYFORD: I am not familiar with it.

MR. DOZE: How are the grasshoppers?

MR. HAYFORD: We have the grasshoppers.

MR. DOZE: Have you ever fed grasshoppers?

MR. HAYFORD: No, we have not come to that point. They are pretty large for the small bass. Of course, we could not get them in quantities. When you get a big plant you have to get something of which you can obtain large quantities.

MR. CANFIELD: What is the average percentage of female small mouth bass that spawn each year?

MR. HAYFORD: The first year I thought I was doing pretty well: I put 29 pair on the nest; and I hatched 24 pair out of 29; but the next year I put 49 pair on and hatched 7.

MR. CANFIELD: What is your average from year to year, over a term of years?

MR. HAYFORD: I would say about 50 per cent. I had a pond of 14 nests this year, and I had 7 very fine nests come up. In another pond I had 20 nests, and I had 11 come up; and I had three or four nests that I did not see at all. But speaking of feeding, to me the thing is to get the facts boiled down to where we can produce a proper food; and then you have got to face the fact that the conditions are not the same in any two places.

MR. CANFIELD: Is it pretty much a local proposition?

MR. HAYFORD: Yes.

MR. MANNFELD: I take it for granted that everybody here is more or less interested in the propagation of the small mouth bass. We have been carrying on some very interesting experiments in Indiana relative to the rearing of the small mouth bass. Much has been said about the feeding of the fish, but we have found by experience in our State that the water supply is absolutely one of the important things.

Two of our hatcheries in Indiana are fed by lakes. One of these lakes, Maiden Lake, is about eight feet higher than our hatchery; it comprises about 360 acres. This lake is full of food life of various kinds—full of vegetation. In our hatchery, which consists of about fifteen ponds, some of them over half an acre in extent, we have repeatedly tried to raise small mouth bass. We have had excellent results with the large mouth in these ponds, but with the small mouth we have had no success. We can get the nests and the fry come up, but they do not live, though there is plenty of food available. On the other hand, we have two hatcheries that are fed by spring water, one at Indianapolis, and one at Bass Lake, and there Mr. Lavery for the last two seasons has had very good luck with the small mouth bass, which he was raising along with some of the large mouth. Perhaps you gentlemen can tell us something about your experiences in that connection, but, stating the case briefly, I would say that the water supply is the big factor in raising small mouth bass. I doubt very much whether anyone will have much success in cases where the lake water is used. Mr. Lydell, whom most of you will recognize, I am sure, as one of the greatest bass culturists in this country, will tell you the same thing. I remember well that in 1907 he told us, "When your State engages in the propagation of bass, especially small mouth bass, do not make the mistake of trying to rear them in lake water." We found that this was borne out by experience. At these particular ponds where we have attempted to raise the small mouth bass there is an abundant supply of many of the ordinary foods—Daphnia, Cyclops, Synura, things that little bass and other fishes live on, yet the results have not been satisfactory, while with the large mouth we have done quite well. I may add that we screen all our nests and take the young fish out and put them in rearing ponds; and we examine the food life to see that it is there so that we may replenish it when it becomes scarce.

We do some things with our bass, perhaps, that I do not know very many others do. For instance, we spawn them more than once. We find that by taking all the breeders out of a pond—in fact, taking all the young fish out first, then removing the nest and seining out the old breeders—putting them in other ponds freshly set and adding some other females and some males, we can get the second spawning. Then, when we get this second spawning we set another pond with nests, take all the fish out again, and put them in a third pond. In that way we get three spawnings, and you would be surprised at the enormous number of fry that are produced in this manner. The question is, of course, what to do with the fry. We have planted many fry that we might have preferred to rear to the fingerling stage. We have some difficulty in raising fingerlings, but this last season we had some on display at the State Fair that were nine inches long. They had been raised on live food—that is something to which Mr. Buller referred; there is no doubt that that is the food that will make them grow fast. We have had some that will grow longer than nine inches in four months

—small mouth bass we have had up to nine inches. That all shows that food is the main thing in the propagation of fish. I have always contended that if you want to rear fish and to get them growing fast you must give them plenty of food, and if you use the right kind you certainly will produce results.

DR. EMBODY: So far as the raising of bass is concerned, the whole matter resolves itself into a question of producing the right kind of food at the right time. If we can get the smaller animals—entomostracans, let us say—in great abundance at the time when the bass are fry, we will succeed at that point. Then we readily pass from that stage to the size where they require larger food, and mosquito larvae would seem to answer the purpose there for a while. From that stage they go gradually into the minnow stage. If we can produce minnows or some other fish—orange spotted sunfish, goldfish, or buffalo fish, so that they will be just about the right size when the bass are ready to feed on them, we will have done something to meet some of these problems in bass culture. The question is how to make available the different sizes of food at the right time, and what species lend themselves best to that procedure. Here there will be a variation, of course, according to the location. It may be that our friends in Kansas can get grasshoppers in sufficient numbers to permit their being fed to the bass; we could not do it in New York—we can hardly catch enough grasshoppers there to fish with. So we must resort to something else, and mosquito larvae seems to come along about the right time; in fact, we can keep it going all summer by using more of the material which produces the culture. As Mr. Hayford has pointed out, the greatest problem there is to prevent the pupal mosquitos from reaching the adult stage. We can feed them before they become pupae all right, but if you allow a great many of them to become adults, they will permeate the neighborhood and make bad neighbors. I cannot see any objection to raising goldfish for the purpose of feeding the young bass from the time they are an inch and a half long and on. In June I happened to visit the goldfish farms in western Maryland; if you have never been there I advise you to go and see how these ponds are manipulated. They have farms comprising anywhere from ten to fifty acres, and it was a revelation to see the swarms of goldfish that were crowded into these ponds. When I saw these fish it occurred to me that there was what we needed to feed our bass. You will all remember that our former member, Professor L. L. Dyche, advocated that very thing in his book on "Pond Fish Culture"; that was the first time I heard the suggestion made. It seems to me that the suggestion is a good one. You can introduce the goldfish breeders into the ponds with young bass; they can spawn there and it will not harm the bass. Young sunfish will eat young bass; at least that is my experience. I do not know whether the orange spotted sunfish will do it, but the common sunfish will clean them up almost as fast as they are put in the pond. Goldfish will not do that; they are quite harmless to the young bass. You

can get your pond fully impregnated with the goldfish; then the young bass, when you turn them in, will clean up the goldfish. It would seem that these are the main problems connected with bass culture at the present time.

DR. OSBURN: Do you mean by the common sunfish, the green sunfish? The bluegill will not eat young bass?

DR. EMBODY: No, I refer to the one, named *Eupomotis gibbosus*. I have my suspicions about the bluegills. I know they will eat young bullheads as fast as they can capture them.

DR. OSBURN: What do you think of the midge larvae versus the mosquito larvae?

DR. EMBODY: I would prefer the midge larvae, but the question is how to produce them in sufficiently large numbers to permit their being fed to the bass. In fact, the mosquito larvae production experiments are an outgrowth of our attempts to produce the midge larvae. Midge larva is a superior food, and of course the adult midge would not do any harm to our neighbors. But they would have to be produced by the millions, and the question is how to do that.

DR. OSBURN: In Ohio waters, judging by the stomach contents, young fish from three-quarters of an inch to an inch and a half feed very largely on midge larvae before they come to the minnow stage of feeding.

FISH DISTRIBUTION BY THE FEDERAL GOVERNMENT.

By E. C. Fearnow,

Superintendent of Fish Distribution
U. S. Bureau of Fisheries

INTRODUCTORY.

In connection with the distribution of living fish there are always two main problems to be considered. The first is how to produce a sufficient number of suitable species to meet the ever-increasing demand; the second, how to obtain sufficient funds to distribute the output which might be produced. As the purpose of this article is neither to consider the methods of fish production nor the means by which adequate appropriations may be obtained, the discussion will be confined to the methods employed by the Federal Government in transporting fish from its hatcheries and collecting stations to various points throughout the states and some of the problems encountered in this particular work.

EARLY HISTORY OF DISTRIBUTION

In the early days of the United States Fish Commission, by which name the Bureau of Fisheries was known until July 1, 1903, the distribution of fish was conducted solely by messengers who travelled in baggage cars on regular passenger trains. The species distributed at that time consisted of a few anadromous fishes which were, as a rule, planted in waters near the points where the hatcheries were located, but as the output of the various stations increased it became necessary to employ more efficient methods of transportation.

The first car load of fish shipped by the United States Fish Commission, and probably the first shipped in the United States, was sent west in June 1873, but the consignment was lost in a wreck near Elkhorn, Neb. An attempt to send a car load of fish across the continent met with success in 1874 when a shipment of shad was delivered in California. Experiments conducted during the years 1879 and 1880 demonstrated that large numbers of fish could be

handled more expeditiously and economically in car load lots than in messenger shipments, and it was decided to construct a car especially adapted for carrying live fish, arranged so that an even circulation of aerated water could be maintained in the vessels containing the fish, and provided with living accommodations for the crew.

In the winter of 1881 car No. 1, a baggage car known as Philadelphia, Baltimore and Washington car No. 4, was purchased and fish-carrying apparatus installed thereon. This car was eventually rebuilt and lengthened to 60 feet.

Experiments with car No.1 were very satisfactory and Congress was asked to appropriate funds for another car which was delivered on May 23, 1882. This was called Baltimore and Ohio Passenger Car No. 450 but in a few years the name was changed to United States Fish Commission Car No. 2.

On July 7, 1884, an act of Congress authorized the construction of car No. 3, the first specially designed fish distribution car in the United States. The refrigerator compartments of this car were placed below the floor with doors opening from above through the floor. The compartments could also be reached by doors opening from the outside, which permitted a clear floor space.

It was found, however, that this arrangement prevented the car from passing over short curves, and the compartments were, therefore, eventually placed above the floor.

Old car No. 4, later changed to No. 5, was a combination baggage and mail car built for a railroad in Mexico. It was purchased by the United States Fish Commission to transport salt water fishes to the World's Fair at Chicago, Illinois. It had no refrigerator compartments, being merely a baggage car equipped with berths.

An act of Congress approved March 3, 1899, appropriated $8,000 for building a new car to replace Car No.4. The new car was designated No. 4 and the older one No. 5.

Car No. 6 was constructed for use in connection with the Louisiana Purchase Exposition in 1904 and at the close of the exposition it was turned over to the Bureau of Fisheries.

The Bureau now operates five cars, Nos. 3, 4, 7, 8 and 9. The three last named are of steel construction and were built within recent years. These cars are so equipped that they can be carried in any of the standard passenger trains. On completion of the three steel cars, four of the old wooden cars (Nos. 1, 2, 5 and 6) were disposed of.

EARLY EXPERIMENTS

It was soon found that, in moving fish in car load lots, it would be necessary to provide means for aerating the water otherwise than by hand. On the first cars the power used to run the pumps was obtained by connecting a belt with one of the axles but this was very unsatisfactory as the pumps could be run only while the car was in motion. Later, a small boiler was used to furnish power for a water circulating pump but was found to be unsuitable.

In 1885 the first hatching outfit was placed on Car No.3 and was used en route to the New Orleans Exposition. The hatching of eggs on the distribution cars was carried on for several years with a reasonable degree of success but as the number of regular hatcheries increased, it was found unnecessary to maintain hatching apparatus on the cars and this part of the equipment was gradually eliminated.

A number of experiments have been made in filtering and refrigerating water used in carrying fish. Filters have been made of gravel and sponge through which water was forced by a pump but they soon became clogged and unfit for use. Car No. 3 was equipped with an air coil made of 1-inch pipe through which water was pumped. The coil was placed in an ice box, the ice being in the center and on top of the coil, but this method of cooling water and air was found to be inefficient in proportion to the amount of ice used.

PROGRESS OF FISH DISTRIBUTION

An idea of the progress that has been made in fish distribution may be gained by comparison of Car No. 2 with Car No. 9, one of the new steel coaches. Car No. 2 carried 92 milk cans or 9,200 3-inch fish. One of the new steel cars will carry 240 pails or 24,000 3-inch fish. This increased efficiency is brought about by (1) building cars with larger compartments and (2) using the same amount of water and more vessels, thereby exposing more water surface to the air. On the assumption that the present carrying capacity of one of the steel cars is 100%, the efficiency of one of the earlier cars was approximately 35%. Twenty-five per cent of the increased efficiency has been brought about by changes in the construction of the cars and 40% by changes in the equipment. Twenty years ago the cost of distributing fish per thousand, based on the Bureau's annual output, was $0.027; during the fiscal year ended June 30, 1923 the cost per thousand fish had been reduced to a little over $0.01.

An idea of the magnitude of the distribution work accomplished by the Bureau of Fisheries may be gained by a study of the records covering plants of fish made in the last twenty years. During that period the output of the various hatcheries amounted to 72,281,380,861 fish. In the distribution of this output, the bureau's cars travelled 2,029,-416 miles and detached messengers 8,104,799 miles.

ASSIGNMENT AND ALLOTMENT OF FISH

In apportioning the bureau's output of fish it is always a problem to decide on what waters are most in need of restocking and the species most suitable for introduction therein. There is a desire on the part of the public for non-indigenous fishes. In some of the northern states where the small-mouthed black bass is common, applicants request large-mouthed black bass, while in North Carolina, Tennessee, and other southern states where the waters are adapted to the large-mouthed black bass, applicants insist that the Bureau introduce small-mouth black bass. Frequently lake trout are desired for stocking waters in southern states and in several instances insistent demands have been made for brook trout in Florida waters. Of course, such requests cannot be granted but it requires a great deal of time and patience to convince the applicants that they should confine themselves to suitable species.

As the bureau has no representative to investigate the condition of the various streams for which fish are desired, it is necessary to rely to a great extent on information furnished by the applicants. Sometimes, however, the bureau consults the state fish commissions in regard to the fish that should be placed in certain waters, this being especially true with reference to requests for spiny-finned species for trout regions.

In order that this information may be accessible at all times, a card index system is maintained showing the species of fish that have been planted in the various streams for a number of years. These plants are followed up at intervals and notations made on the cards showing what results attended each planting. The system will eventually become a complete index of streams in the United States and will show the results that have followed each planting of fish.

The number of fish can be furnished an applicant depends on the area of the water to be stocked, size and number of fish available for distribution, and distance the fish have to be transported.

PREPARATION OF FISH FOR SHIPMENT

The distribution problem begins at the hatchery and it is necessary, therefore, to use proper care in preparing the fish for shipment if they are expected to withstand the vicissitudes of transportation. Fish are necessarily transported under unnatural conditions and diseased or weakened fish that cannot be held at stations without considerable loss cannot be expected to survive in transportation cans for days and even weeks.

Warm-water fishes, in order to be successfully transported, should be held in cool running water until they have become "hardened". The importance of "hardening" fish was recently emphasized by several shipments that were sent to Central Station, Washington, D. C. In one instance, five cans of gambusia were collected from warm stagnant water and immediately shipped. The consignment arrived in very poor condition and within twenty-four hours every fish had died.

A shipment of the same species was then ordered from another station, the time involved in shipment being about the same. The consignor, in this instance, made the collection and held the fish in cool running water for about thirty-six hours. It is needless to say that this consignment, which was forwarded to Washington, D. C. without an attendant, reached its destination in excellent condition and the fish were successfully reshipped to various points throughout the country.

An idea of the importance of shutting off food in advance of shipment may be gained by reference to a consignment of trout forwarded from one of the bureau's hatcheries to Washington, D. C. Two pails of fish were forwarded under identical conditions except that the fish in one pail had been fed within twenty-four hours of shipment. In the second pail the fish had not received food within thirty-six hours of shipment. On the arrival of the consignment at Central Station, the fish that had not received food for thirty-six hours were in excellent condition, while those in the other pail were in but fair condition.

When fish which have cannibalistic tendencies are to be shipped, it is quite important that they be graded so that fish as near the same size as possible will be placed in a can.

If care is used in preparing fish for shipment, there is no reason why such species as black bass, bluegill bream and other warm-water species cannot be successfully transported for weeks and probably months.

TRANSPORTATION OF FISH

When a distribution is to be made by one of the specially equipped cars, the first matter of importance is to arrange the trips with reference to the accessibility of the applicants, who may be located in half-a-dozen different states. As the cars are now equipped for carrying large loads of fish, it frequently occurs that as many as 150 individual applicants are supplied on a trip. Schedules for the car and for the messengers are necessarily prepared in advance and applicants notified by letter or by telegram concerning the exact time that delivery of the fish is to be made. Owing to the uncertainties of railroading, it frequently becomes necessary to rearrange the whole schedule and renotify all applicants.

It is the rule to move the car to a certain point, dispatching en route messengers who either fill applications on roads parallel to lines traversed by the car or pursue a circular or semicircular route, joining the car further along the line. The most expensive messenger shipments are those in which the messenger has to retrace the same line, and the least expensive and the ones most frequently made are the circular, semicircular and triangular. Happily, there are few trips made at the present time that necessitate return travel without fish. Shipments off the main lines are usually made by express or in care of train baggage masters. Shipments without attendants are made to probably 95% of applicants living off the main lines, necessitating over 1,000 such shipments in the course of a year. There are on record many messenger shipments in which 75% of the deliveries were made successfully without an attendant.

In distributing the annual output of the Bureau of Fisheries it is necessary to use, in addition to the regular distribution force, probably as many as 150 station employees who from time to time, make trips from the various hatcheries.

RAILROADS

A number of the important railroads of the country have extended courtesies to the bureau in the way of reduced transportation rates for the movements of its distribution cars. Practically all the important railroads have given the bureau the privilege of carrying in baggage cars free of charge shipments of live fish, the only condition imposed being that the consignment be accompanied by an attendant with first-class transportation.

As a rule, however, the railroad companies are more liberal to the states than to the Federal government. It is

well known that free transportation is extended to messengers of state fish commissions while regular fares are required of the bureau's messengers doing distribution work within the limits of the same state. While, in special cases, free transportation has been furnished the bureau's cars and messengers, such courtesies on the part of the railroads call for increased efficiency on the part of the recipient. That free or reduced transportation is accorded is no excuse for not employing efficient and economical distribution methods. As reduced transportation carries with it the obligation to use the most efficient methods, it is an abuse of the privilege the railroad company has extended to carry two or three times as much water as is necessary for the safe transportation of the fish. Within recent years the public has been taught, after a great deal of effort, to judge a consignment of fish not by gallons of water or number of cans but by its value for stocking purposes.

The railroad companies have been quick to grasp the economic value of the new transportation pails described by the writer before the meeting of this society last year, as evidenced from the fact that the roads which formerly insisted that not more than twenty of the old-style cans be carried by a messenger are now permitting forty and sixty of the new pails to be so handled, when stacked so as not to require more floor space than was formerly required by twenty milk cans.

TEMPERATURE OF WATER DURING TRANSPORTATION

In transporting fish an equable water temperature is of vital importance. It is generally accepted that low water temperature within reasonable limits is desirable as the cooler the water the more gaseous oxygen it holds in solution. The temperature of the water from which the fish were taken and the temperature of the water to be stocked should guide the messenger in the regulation of the temperature during the period that the fish are in transit.

On each fish car there are two compartments, well insulated, so that a proper temperature may be maintained in the fish cans with a comparatively small amount of ice.

AERATION

For a number of years the bureau's distribution cars have been equipped with air compressors operated by 10 H. P. boilers. The air is driven through air distributors in the fish compartments, into rubber tubes leading to groups

of from 4 to 6 containers and forced into the water through plugs of porous wood, preferably American Linden.

Recently there was installed on Car No. 8 a Worthington feather-valve air compressor operated by a ½ H.P. electrically-driven motor connected with the storage batteries used for lighting the car. This device furnishes a sufficient amount of free air to aerate the water in from 200 to 300 pails and has been used continuously for 14 hours without producing any apparent deterioration in the batteries which have a capacity of 375 ampere hours. As train line air is available when the car is in motion, the electrically driven compressor meets all requirements while loading the car and during layovers at junction points. making it unnecessary to use the steam boiler.

AIR LIBERATING PLUGS

The wooden plug which has been employed for liberating air in fish containers has a number of disadvantages when used in connection with modern equipment. In recent years it has been difficult to obtain wood of the same degree of porousness so that all plugs will liberate the same amount of air. If for any reason the air pressure is shut off for a time the wooden plug absorbs water to the extent that it fails to liberate air when the pressure comes on again. Under such circumstances it is necessary to go over the entire load of fish as rapidly as possible and regulate the amount of air in each pail. It is needless to state that the plugs when they become dry contract and this makes it necessary to completely overhaul the equipment after each trip.

ALUMINUM PLUG

An aluminum plug for use in equalizing the air either in the pet cock which leads to the air distributor or in the outlets of the air distributors, was recently devised, and supercedes the wooden plug. The plug is made of aluminum rod and threaded to fit into the air pipe. It has a 1/32-inch tube drilled through it longitudinally and two 1/32-inch holes are drilled through it transversely near each end and intersecting with the tube in the center, which allows 5 openings on each end of the plug. With this arrangement there is little difficulty in maintaining an even air pressure in the air distributors and containers even though one or more of the distributors is disconnected.

"FILTROS"

Experiments are being made with "filtros," a rock-like substance which may be purchased in cylinders 5/8-inch in diameter and 6¼ inches long. This material is quite porous and while it disintegrates in the course of time, it lasts about four times as long as wood when used for liberating air. "Filtros" does not contract when not in use and therefore requires little attention in the way of adjustment However, the experiments with filtros have not been carried far enough to warrant its general use on fish distribution cars.

JET AERATOR

During the spring and summer of this year a new aerating device which circulates the water in the container and operates by air was used to a limited extent on the distribution cars with very satisfactory results. This aerator was devised for the purpose of aerating the water and removing the carbon dioxide gas given off by the fish.

The device consists of a tube placed on the inside of a larger tube, care being taken to allow room enough to permit the water to be forced up in the space between the two tubes.

There has always been a question in regard to whether the liberation of free air in water is the best method of aeration. It has been noticeable for a number of years that when air circulation is discontinued the fish show signs of distress in ten or fifteen minutes while, if the water is thoroughly aerated by dipping or pouring, they may be left without aeration for as long a time as one hour. The jet aerator, by throwing the water into the air, furnishes a more natural aeration.

The following extract taken from the log of Car No. 8 is typical of reports received from those who have tried the jet aerator:

"These aerators showed their superiority over the ordinary wooden plug when a number of fingerling sunfish were moved from La Crosse, Wisconsin, to Denver, Colorado, in July of this year. When received on the car, these fish had just come out of hot sloughs along the upper Mississippi River and were very weak. There was a rather heavy loss but the pails having the jet-pump aerators in them had considerably less loss than the other pails with wooden aluminum plugs."

Experiments with this device are still being carried on and while its practicability is not generally perceived at

the present time, it is believed that it will be more fully appreciated when further improvements are made in other transportation equipment.

A system of water circulation which was tried out years ago was a failure for the reason that the water when passing through the pump picked up a small amount of oil which proved inimical to fish life. There was also some difficulty in regulating the overflow or return from the various cans. Since all the water returned to a central tank, one can of diseased fish might infect the entire shipment. The jet aerator, by circulating and aerating the water in each container overcomes these difficulties. The underlying principle of this aerator may be applied to a device for lifting water or removing sediment from the cans.

AERATOR FOR MESSENGERS

Within the last year the dipper which was used for aerating water has been largely replaced by the "Question Mark" aerator, so named on account of the bend in its handle which is made of ¼-inch pipe and serves as an air vent and means for suspending the aerator in a fish can when not in use. The cylinder of the aerator is made of galvanized rain spouting and is 4½-inches in diameter by 6-inches in length. The bottom contains twenty-one circular openings which are screened to prevent fish from entering the cylinder. The handle may be unscrewed and the device carried in a small hand bag.

The device provides quick and efficient aeration, does not injure the fish, can be used to remove sediment or to lower the water in a container, and has a number of other advantages over the ordinary dipper.

The Question Mark aerator has met with general approval as it seems to answer the bureau's needs better than any device that has heretofore been used.

PLANTING FISH

Closely linked with distribution work is the planting of fish. While much has been written on fish propagation, it seems that comparatively little has been said on fish planting. The tendency has apparently been to produce fish and trust to Providence to care for them, regardless of whether planted in unfavorable environment.

Too much care and attention cannot be given to fish planting, as it is here that all the efforts of the fish culturist may be placed in jeopardy. The practice has been to

get the fish into waters as soon as possible, frequently dumping the entire consignment into one pool at some convenient point such as a bridge or ford where the young fish merely serve as food for a few larger ones. The importance of carrying fish to the headwaters of streams where there is plenty of natural food and immunity from enemies, and depositing them in small lots in shallow spring-fed pools, is not fully appreciated by all who make plants of fish. Fish produced at great expense may be wasted by placing them in unsuitable waters, or in suitable waters under adverse conditions. The stations' output for an entire season may be completely lost, so far as increasing the food supply is concerned, by injudicious methods of transporting and planting the young fish.

CONCLUSION

Fish properly hardened and graded may be carried for an indefinite time in suitable vessels, means being provided for controlling the temperature, removing the sediment and adding enough water to compensate for that removed. If shipment is made during warm weather, the melting ice will afford a gradual change of water.

From 10,000 to 15,000 individual applications are filled annually by the Bureau of Fisheries. The distribution field includes practically every state in the Union; besides, shipments have been made to Central Mexico, Porto Rico and the Canal Zone; and only recently a consignment of gambusia was sent from Edenton, North Carolina to Palestine.

Five years after plants of fish are made the results are ascertained. This is the day of reckoning, for if the plants have not been successful, "our sins will surely find us out." Thousands of reports are received—excellent 31 per cent, good 24 per cent, fair 13 per cent, and only 14 per cent in doubt. Hundreds of letters are received testifying to the remarkable success that has followed the stocking of streams, lakes and artificial ponds that contained no fish life prior to its introduction by the bureau.

The distribution of fish is one of the most important phases of fish-cultural work. It might be compared to the dissemination of seed grain. The end and aim is to increase the supply of desirable fish in streams and lakes.

PRODUCTION OF THE FRESH WATER MUSSEL.

By H. L. Canfield,

Homer, Minnesota.

The Mississippi and its tributary rivers are the greatest producers of warm water fishes in the world, and practically all commercial fresh water mussels are produced in the waters of the Mississippi basin. In time of spring flood the Mississippi overflows its banks and inundates the islands and adjacent lowlands in which are located sloughs, pools and other depressions, and into this territory many fishes go to feed and spawn. Later in the season the river recedes into its banks and becomes quite low, leaving many of the fishes in the depressions. As the season advances and the land-locked waters become low and stagnant due to the low stage of the river and to seepage, millions of fish are left high and dry to perish unless removed to live waters.

During the fiscal year 1922, the U. S. Bureau of Fisheries rescued from these land-locked pools of the Mississippi River over 139,000,000 stranded game and commercial fishes of various ages and sizes, and released on the gills of suitable host fishes, in a state of parasitism, over two billion larval commercial mussels.

The fresh water mussel is in great demand for use in the manufacture of pearl buttons and the supply has become so short that mussels sold at $10.00 and $15.00 per ton ten years ago are now easily disposed of at $60.00 to $90.00 per ton. The necessity for protecting measures and artificial propagation of mussels is therefore easily understood. In mussel infection work, quantities of fishes are required, so the rescue of stranded food fishes and mussel infection are combined to great economic advantage.

The larval mussel is developed in the adult female mussel, then freed as a parasite into the water. To live it must within a very limited time attach itself on the gill of a proper host fish. Here it encysts and passes through a metamorphosis which changes its internal structure. In about two weeks or more, according to the water temperature, it releases itself as a juvenile mussel, to commence its independent life. Th larval mussel is of light weight and is therefore held in suspension by the water for a short time. This is a very critical period of the larval mussel's life, for it

is necessary that it attach itself almost immediately to a host fish by clamping its tiny valves to the gills of the fish. (Only one of the commercial mussels becomes parasitic on the fins of fishes.) The larval mussel has no power of locomotion, so unless conditions are very favorable it will fail to meet with a host fish and will fall to the bottom and perish. The greatest loss of mussel life under natural conditions is due to the failure of the larval mussel to connect with its host fish. Artificial infection of fishes bring the mussel and its host fish together.

After the land-locked fishes have been rescued and taken to the open waters, such suitable host fishes as are available are placed in clearing tubs preparatory to the infection. A ripe female mussel is then opened and the larval mussels from her gill pouches released in the tub with the fishes and the water gently stirred. The myriads of larval mussels held temporarily in suspension give the water the appearance of being milky and the tiny larval mussels constantly open and close their valves in their attempts to attach themselves to the fishes. As the fishes pass the water through their gills in process of breathing, the larval mussels are carried againt their gills with the water and they readily attach themselves. After the infection has been effected, the fishes are released in the open water with a positive and correct infection of larval mussels.

If the juvenile mussel drops on favorable bottom, and is not destroyed or devoured by enemies, it grows and matures in from three to five years and is suitable for use in the manufacture of pearl buttons in from four to seven years, depending upon the species of mussel and its environment.

Discussion.

DR. OSBURN: To what extent are the fish that are of no particular use for any other purpose available for mussel growth?

MR. CANFIELD: The most striking instance of that kind is found in the common river gar, which, I believe, is of no commercial value and is usually thrown out when caught in the commercial fisherman's net. This gar is the only known host fish for one of the highest priced commercial mussels that we have. Another instance is that of the river herring, sometimes called the skipjack, which carries the niggerhead mussel, one of the important commercial varieties.

MR. AVERY: Would it not be interesting if we could hear something more about the different varieties of fish that are hosts to the various kinds of mussels?

MR. CANFIELD: The United States biological station at Fairport has worked out very definitely the various host fishes of all the com-

mercial mussels. In the slides that will be thrown on the screen later, a number of host fishes will be shown. Such fish as the black bass, crappie, sunfish, sauger, perch and pike are very useful hosts in carrying what is known as the river mucket and the Lake Pepin mucket, two of our most valuable button-producing shells. The sheephead is the only known carrier of the butterfly mussel, another very good commercial mussel. Then, such fish as the yellow perch also carry the mucket, and catfishes carry the Quadrula mussel, the exterior of which is rougher than that of the other types. The two main groups are the Lampsilus group and the Quadrula group; most of the Quadrulas are carried by catfishes and other lake fishes.

MR. POPE: Is it possible to raise mussels from the glochidia stage to the adult stage without the intervention of a host?

MR. CANFIELD: There is just one mussel we know of that produces an adult without its passing through a state of parasitism on fishes, and that is known as the squawfoot mussel, which is of no commercial value. There is, however, some question about that; it is also known that the squawfoot mussel uses fishes as hosts.

MR. POPE: Has it ever been established whether the encysting of glochidia in the fins or gills of fish is for the purpose of protection, or for the desire for food?

MR. CANFIELD: Dr. Avery, as I understand it—I may be speaking a little in advance, as he has not yet published his paper on the subject—has very definitely shown that the mussel consumes food from fish. I presume he would not object to my making the statement, although, as I say, he has not yet published the results of his researches.

MR. POPE: Do you believe that the encysting is for the purpose of obtaining suitable food?

MR. CANFIELD: I am satisfied from the slides which Dr. Avery showed me—it is entirely his work, not mine—that the mussel consumes a portion of the fish. In fact, the part that the tiny larval mussel bites on to is eaten, if you can express it that way, by the cells during the time that the larval mussel is passing through the metamorphosis.

MR. POPE: Has the Bureau of Fisheries ever carried on any experiments to determine whether it is possible to raise glochidia to adults without the intervention of a host fish?

MR. CANFIELD: Yes, but so far, all have been unsuccessful.

MR. AVERY: Experiments in that line are still being conducted?

MR. CANFIELD: Oh yes.

MR. POPE: What percentage of adult mussels have been known actually to develop from glochidia encysted upon fish?

MR. CANFIELD: You have asked me a difficult question. I do not think we have any figures on that.

MR. POPE: What percentage would you suggest?

MR. CANFIELD: I should think that if we got one in a thousand to maturity, we would be doing very well.

MR. POPE: Do you think it would be advisable, or have any experiments ever been made to that end, to provide suitable food for the glochidia other than living fish, thereby largely increasing the percentage of glochidia that reach the adult stage?

MR. CANFIELD: We have no figures on the subject; there is no one who could tell you definitely how many might be expected to develop under those conditions. But it has been definitely shown that if the mussel attains an age of six or eight months there is very little likelihood of its meeting with enemies, and the chances are that you would get a very heavy percentage in that case. The greatest death rate is in the juvenile stage, after it leaves the fish. Of course, the great trouble in nature is that it would be more or less an accident if the proper host fish should happen along just as the female mussel happened to release the larval mussel. However, it is said that in some cases the mother mussel attracts the fish to it by means of its waving cilia-like fringes. But we do not know even that. I may say that in several plants that we made, we recovered after two years practically one hundred per cent of the mussels that we placed out, but these were not placed out until they were about six or eight months old. With protection you could place even the larval mussels out, but unprotected there would be considerable loss.

DR. OSBURN: Does the sheephead prey on mussels?

MR. CANFIELD: The sheephead is said to be an enemy of the mussel; both the sheephead and the catfish have been known to devour them, also the pumpkin seed sunfish. I have no doubt that many fishes will take them during the juvenile stage.

MR. POPE: Do you know of any experiments that have shown that the glochidia are actually led by instinct to choose certain kinds of fish, or is the fastening on a host an act of a mechanical nature?

MR. CANFIELD: It is entirely of a mechanical nature.

MR. POPE: Then why does it not take hold of the carp?

MR. CANFIELD: They do take hold of the carp; they take hold of any fish, but they do not remain on them—they are sloughed off or released either by the fish or by the mussel prematurely.

MR. BURNHAM: How do the protective laws protect the mussels? Is it by providing a close season, or by limiting the size that may be taken?

MR. CANFIELD: Mainly by closing certain areas alternately. For example, at a certain place they would perhaps close the upper part of the river for a distance of five miles, while the lower part of the river would be left open, the idea being to allow clammers and others who are engaged in the industry to continue their operations and at the same time to permit the closed portion to recuperate. Then, at the end of five years, which is regarded as a suitable length of time to allow the mussels to mature, they will change about; the open area will become closed and the closed, open. In that way it is planned to keep up the industry and also the mussels. I have every reason to believe it is an excellent law.

MR. AVERY: The regulations of the various states also provide for the licensing of fishermen, limitations as to the sizes to be taken, and various other regulations and restrictions?

MR. CANFIELD: Yes—restrictive legislation.

ANGLING: PAST, PRESENT, FUTURE.

By Dr. James Alexander Henshall.

The Art of angling is as old as civilization, and has been handed down to us through the fog and dust of remote ages. The fish hook is mentioned in Holy Writ by the prophets Job and Amos, which fact, as Father Isaak Walton observes, "must imply anglers in those times." The art of angling and its practice, with the tackle then used, has been vouchsafed to us by authors who lived four or five centuries ago.

The first book on the art of angling was written by a woman, Dame Juliana Berners, a lady of noble birth, the Prioress of Sopwell Nunnery, near St. Albans, England. Her book was entitled a *Treatyse of Fisshynge With an Angle*, and was published at London, England, in 1496. In this volume, or "plaunflet", as she called it, she gives explicit directions for making rods, lines, hooks, floats and sinkers, illustrated by rude wood cuts. She also gives the formulas for the dressing of twelve artificial flies, most of which with slight modifications are in use to-day.

Dame Juliana gave precedence to the sport of angling over the then popular sports of hunting, fowling and hawking. Her advice to anglers is just as applicable to anglers of the present day. The angler is counseled to take but few fish at any one time; not to fish in private ponds or preserved waters without permission, nor to trespass on private property, or to break down hedges, or to leave gates open. Also to protect fish from their enemies; and, in modern diction and spelling, concludes thus—"And all those that do after this rule shall have the blessing of God and St. Peter, which he them grant that with his precious blood us bought."

Angling, she assures us is conductive to long life and happiness, and believes that it is not all of fishing to fish, for she says "if the angler catch fish no man is merrier than he," but if he catch no fish and is "wet-shod to the tayl," yet at the least he hath his wholesome walk, and merry at his ease; a sweet air of the sweet flowers of the mead maketh him hungry; he heareth the melodious harmony of the birds."

The next book on angling, in chronological sequence, was *The Book of Fishing*, by Leonard Mascall, published in London, in 1600. A half century later *The Art of Angling*, by Thomas Barker, was published at London, in 1651. Barker's directions for fly-fishing were afterward adopted by Isaak Walton in his great angling classic, *The Compleat Angler*, or the "Con-

templative Man's Recreation," which was published in London in 1653. This well-known and remarkable book, which treats of many subjects in addition to angling, has run through more than a hundred editions, edited by various persons in Great Britain and the United States.

Walton was essentially a bait-fisher, and his book relates mostly to bait-fishing, but some twenty years after the first edition of his wonderful book, there was added to it Part II, by Charles Cotton which comprises his "Instructions how to angle for a trout or grayling in a clear stream." These directions treated mostly of fly-fishing, and the original book has since been known as *Walton & Cotton's Complete Angler.* Isaak Walton, the patron saint of all good anglers, declared, more than three hundred years ago, "Angling to be an art, and an art worthy the knowledge and practice of a wise man." His book is so universally known that any further reference to it is not necessary.

During the latter part of the eighteenth century and in the nineteenth century many books on angling were published in Great Britain, good, bad and indifferent. In the United States the earliest books on angling were published in the nineteenth century. Among the first, most noteworthy and thoroughly American, were the *American Angler's Book,* by Thaddeus Norris, treating of the brook trout and other fresh water fishes. About the same time was published *Fishing in American Waters,* by Genio C. Scott, on the striped bass and other brackish water species. Then came *Game Fish of the North,* and *Superior Fishing,* by Robert B. Roosevelt, all being most excellent works. Since these pioneer American books on angling, many others have been issued, some of much value, others meritorious and desirable.

To return to Dame Berners, it may be well to give a list of the fishes described by her in her treatise, and to refer to the baits recommended for their capture. To her great credit it may also be said that she mentioned only a single hook for either the artificial fly or for natural baits. What a sad and reproachful comment on our methods of the present day when artificial lures are made of wood, metal or bone, each bristling with from three to a dozen murderous fish hooks, and the same may be said of Walton and Cotton and the anglers of their time.

Substituting modern orthography, Dame Berners says of the salmon: "For by cause that the salmon is the most stately fish that any man may angle for in fresh water, therefore I propose to begin at him. The salmon is a gentle fish, but awkward to take." For baits she names the red worm and a "sovereign hait" that breeds on a water dock; "Also you may

take him with a dubbe (artificial fly), at such time as he leapeth, in like manner when you take a trout or a grayling."

For the trout she names the "stone fly," several worms and grubs, "grasshops" and crickets, and "ye fat of ye bacon." The grayling she says, "is a delicious fish to a man's mouth," and is to be fished for with the same baits as the trout. Descriptions of barbel, carp, chub, bream, tench and roach follow, all to be taken with worms of various kinds, pastes, and natural baits. Then come the pike and perch, concluding with the eel.

In the foregoing list only the salmon and the pike are natives of the United States, although the perch, trout and the grayling are more or less closely allied to our own fishes of the same names. The coarse fishes mentioned are not true game-fishes, and belong mostly to the minnow family (*Cyprinidae*), but as they are found in free water, the fishing of nine-tenths of English anglers is restricted to these common forms.

Of the pike the Dame's discourse is thus: "He is a great fish; but for he devoureth so many as well as of his own kind as of other, I love him the less." For baits she recommends minnows, fresh herring and frogs, and young mice, with particular directions as to placing them on the hook.

It may be as well to note the tools and tackle recommended by the good Dame four centuries ago. The rod was made in three pieces, or joints, and was about fifteen feet long; the butt piece was made hollow to accommodate the two smaller joints, when the whole could be used as a walking-staff, and as Dame Juliana says: "and there shall no man know whereabout you go." I have known this ruse practiced successfully where a law prohibiting fishing on Sunday is rigidly enforced. The butt of the rod was fashioned of ash, hazel or willow, the second piece of hazel, and the top piece of the green shoot of hawthorn, crab, or juniper. All the joints were thoroughly straightened and dried. The line was made of six hairs from the tail of a white horse, dyed, and twisted together with the aid of a simple device, shown by a rude figure. For trout and grayling the hairs were left white. Full directions were given for making hooks, floats and sinkers. From this it will be seen that the angler of the Dame's day was independent of tackle stores even if there were any.

Passing by the unimportant and little-known books of Mascall and Barker, we come to the wonderful *Compleat Angler*, by Isaak Walton, published a century and a half after Dame Juliana Berner's quaint and marvelous *Fisshynge Wyth an Angle*. It should be remembered that these two books are entirely original, and made of whole cloth. The rod recommended by Walton was "five or six yards long," depending on

the width of the stream. His line, like Dame Juliana's was made of six white horse hairs, dyed, and twisted, if of seven hairs the center was a black one. "But," he says, "if you can attain to angle with one hair, you shall have more rises, and catch more fish." Of the rest of his tackle we may judge from the following:

"My rod and my line, my float and my lead,
My hook and my plummet, my whetstone and knife,
My basket, my baits, both living and dead,
My net and my meat, for that is the chief,
Then I must have thread, and hairs great and small,
With mine angling-purse, and so you have all."

From this list of essentials it may be inferred that Walton was primarily a bait-fisher, as artificial flies are not included. Artificial flies and fly-fishing originated with the ancient Romans, and by them was introduced into Britain. It was through the example of Charles Cotton that Walton became interested in fly-fishing. They fished together many years, and Cotton, in admiration and affection for his "father" Walton, built the famous fishing lodge on the River Dove, in England, for their accommodation. Although it seems but a step from the days of Berners and Walton and Cotton to our own, it has taken four centuries to arrive at our present knowledge of angling, and the marvelous perfection of tools and tackle, but none the less do we venerate and revere the names of those pioneers in the art of angling.

At the Columbia Exposition, or World's Fair at Chicago, in 1893, was the most wonderful exhibit of angling tools and tackle accessories that the world has ever seen. As Assistant Chief of the Department of Fisheries, that exhibit was peculiarly my own. Among the notable exhibits were split-bamboo rods made by the inventor, Samuel Phillippe, of Easton, Pa., and of others of the best makers since his time. Also there was a fine collection of the famous Kentucky reels from those of the inventor, George Snyder, of Paris, and those of his successors the Meeks, Milam and Sage of Frankfort, and Hardman of Louisville. It was a wonderful collection and a revelation as showing to what a state of perfection had been reached since the time of Berners, Walton and Cotton.

It happened that August 9th, 1893, was the tercentennial anniversary of the birth of Isaak Walton, and it was to occur at the height of the great Exposition. I determined, therefore, to celebrate the event in a becoming manner. I arranged with the Chicago Fly-Casting Club to erect a replica of the renowned fishing lodge built on the River Dove by Charles Cotton for the accomodation of Walton and himself. I enlisted the interest and co-operation of Mr. R. B. Marston, Editor of

the *Fishing Gazette* (London), who furnished specifications, descriptions and photographs of the little edifice, and with the eminent services of Mr. Burnham, chief architect of the Exposition, a perfect reproduction of the Walton and Cotton Fishing Lodge was erected on the bank of the Lagoon in the grounds of the Fair White City, where it proved to be the Shrine and Mecca for anglers from the world over. It was the headquarters for many angling events and numerous casting tournaments.

"The strangest part of the matter," said Mr. Marston afterward in the *Fishing Gazette*, "was that notwithstanding the hundreds of angling societies in England, and a number of angling journals, mine among the rest, no one, evidently, thought of so important an event as the tercentenary of Walton's natal day, but it was left to an American angler and an American angling club to celebrate and honor the occasion in such a splendid and appropriate way."

It is now thirty years since the Chicago World's Fair, but it was twenty years before, in 1873, that I began the crusade to give the black bass its proper place among game-fishes, and to call attention to its possibilities both as a game-fish and a food fish, and to make known the most suitable tackle for its capture, in order to prove it "inch for inch and pound for pound the gamest fish that swims," and to verify my prediction that, eventually, it would become "The great American game-fish." At that time, however, there was not a single article of tackle made especially for black bass fishing except the Kentucky reel. At that time the real art of black bass angling was confined to a small zone of the middle west, of which the "blue grass section" of Kentucky was the center. Outside of that area black bass angling, as an art was unknown. The earliest angling books by American authors, as before mentioned were published during the sixties, namely those of Browne, Norris, Scott and Roosevelt. Evidently these authors knew little or nothing of the black bass or black bass angling, inasmuch as they were either silent on the subject or dismissed it with a few words; Robert B. Roosevelt, however, referred to several incidents of black bass fishing in Canada.

Thirty years afterward, at the Chicago World's Fair, it was demonstrated that in the Angling Exhibit there were more different articles of fishing tackle made especially for black bass than for all other game-fishes combined. At that time it may be said that black bass angling was never better, and the species never more abundant. The inland streams were comparatively pure and undefiled, and coastal waters uncontaminated. But, alas, the great popularity of black bass angling proved to be our undoing. Unheard of and uncouth mul-

tiple-hooked artificial lures of wood or metal, known as plugs and kill-devils, began to be advertised in the fishing journals by profiteers, few of whom were anglers, and they persist to this day, a bar-sinister on the escutcheon of true sportmanship, and a disgrace to the gentle art of angling. It is only by propaganda of education that our erring brother anglers can be induced to forsake these vile implements of destruction and resort to honest and ethical means and methods of angling.

We have received the art of angling as a sacred trust and heritage from times of great antiquity, and it behooves all honest anglers to see to it that the trust be righteously and faithfully regarded. From remote ages, from Biblical times, through the dark ages, and the days of our Mother Superior and Father Isaak to the present day, it has been proved that age cannot wither nor custom stale the gentle art of angling.

It has been a pleasant task and a labor of love to trace the past records of angling down to our own times, but I am now obliged to broach a subject both unpleasant and forbidding, but one, nevertheless, that must be earnestly and intelligently considered, if we are to have any fishing left for black bass or for any other game-fish in either fresh or salt water. We are confronted by the most serious and appalling menace of this century in the pollution of our inland and coastal waters. Inland streams are, as you know, poisoned by industrial offal and waste, and the coastal estuaries by the deadly effects of oil pollution from tankers and oil-burning vessels. This means that not only angling, but commercial fishing as well, is almost a thing of the past in certain sections. These facts are so evident and apparent that it is up to this competent and tutelary society to work while it is yet day, for the night cometh when it will be too late to save what little remnant is left of our once glorious heritage of the piscatorial wealth bequeathed to us by past centuries.

And now, as to the future. Watchman, what of the night! The famous electrician, Dr. Steinmetz, tells us that the people of the next century will wonder at our ignorance; that everything at that time will be done by electricity, and that they will work but four hours a day; Well, they will have more time to go a-fishing, provided there are any fish to be caught, which is problematical. I would not care to live in the next century and take the chances.

But, seriously, something must be done and done quickly. We must co-operate with the manufacturers to do away with pollution by reducing it to a condition where it will be harmless to animal life, and at the same time be a source of profit to themselves; a proceeding that has already been consummated. If this can not be done through moral suasion,

then the law must be invoked. As I have stated elsewhere, more than once, our diminished streams may be augmented by boring artesian wells along their banks, whose flow of water, when aerated, would furnish an additional supply of oxygen. This is not at all chimerical. When a schoolboy my geography taught me that there was three times as much water as land on the globe; and as there is nothing that has ever existed on this planet that is absolutely destroyed, that proportion of water must still exist. There are the seas, lakes and rivers on the surface, and "the waters under the earth." These subterranean waters can be reached and utilized through artesian wells of various depths. There are many small cities and towns that procure their water supply in this way.

When I was transferred as superintendent from Bozeman, Montana, to Tupelo, Mississippi, I found a dozen artesian wells on the grounds of the latter station, about four hundred feet in depth. When first bored they were flowing wells, but when the city of Tupelo bored a well about a thousand feet deep for an additional water supply, it caused the water in the wells of the station to drop about ten feet below the surface, and the water had to be pumped. There were but two of the station wells in use, operated by steam pumps. There were three ponds, and this supply of water was inadequate, for the output of large-mouth bass had never exceeded twenty thousand at any one season. I did away with the leaky boiler and the steam pumps and substituted electric motors and four pumps, and thereafter the output was never less than three hundred thousand per season. If funds had been available half a dozen more ponds could have been constructed, and the rest of the wells utilized, and the output could have been increased to a million each season. In this connection it is as well to say that when our streams have diminished in size and purity, and are fishless, artesian wells may be bored on farms or other private property, and stocked with fish.

I have an abiding faith in the integrity and practical working of the American Fisheries Society. Because I am one of its oldest members, and have served as its president, I trust the Society may see its way clear to adopt a resolution memorializing the Congress to institute measures to abate or mitigate the pollution of navigable rivers and coastal estuaries. And I feel sure that individual members of the Society from the various states will give aid and comfort to any state movement looking to the alleviation of pollution of inland waters from industrial waste and sewage, and will assist with their counsel and influence in the work of any combined effort by protective associations or conservation organizations, or in

needed legislation of their states. And I want to assure them that I am not crying "wolf, wolf," to urge others to their duty, but that I am now, in eighty-eighth year, doing my bit for conservation with the Isaak Walton League of America and in conducting the department of pollution in its monthly magazine.

NOTES ON THE PROPAGATION AND DISTRIBUTION OF POND FISHES.

By G. W. N. Brown.

The U. S. Fisheries Station, Orangeburg, S. C.

From observation and study of the spawning habits of pond fishes it is learned that the proper manipulation of the water supply is a factor in incubation that should not be overlooked. Especially is this true in regard to the incubation of black bass eggs. Black bass begin nest building and spawning during the first warm weather of the season, which occurs, usually, about the middle of February. They seek the shallow portions of the pond as the warmth of the sun has there penetrated to the bottom. As is well known the male fish remains with the nest after the spawning is concluded. His purpose in this is not only to protect the eggs from enemies, but also, to keep the water constantly changing on them so that they may obtain the proper amount of oxygen which is necessary to incubation as to the life of the fry after hatching. He accomplishes this function by passing back and forth over the nest with a gentle undulating motion of the fins. By this means he also prevents sediment from collecting on and smothering the eggs.

Should anything occur to drive the male from the nest for any considerable length of time the eggs, thus deprived of his parental care, soon die. As the warm periods are invariably followed by cold snaps which chill the surface water it is necessary to close the supply valves to prevent the cold surface water from the reservoir from displacing the warm water at the nests and driving the male fish to seek a more equable temperature in the deeper section of the pond. For this reason the supply valves are closed at the Orangeburg station until all danger of cold snaps has passed, sometimes remaining closed for four or five weeks.

A former custom of bunching the brood fish in a few ponds for the winter and distributing them to the various spawning ponds early in February has been abandoned. It was found that better results can be obtained by placing them in the fall, after the ponds are drawn and cleaned, in the ponds in which they will remain during the spawning season, as it obviates the necessity of handling them after

the eggs are nearing full development. About 35 pairs are placed in an acre of water.

An experiment in hatching bass eggs in a trough was conducted at this station last spring. A nest of eggs found on the morning of March 5, believed to have been spawned the previous night, was taken up and counted and found to contain about 4,500. They were placed in a trough of running water on a cheesecloth tray. They were showing the eye spot on the 7th and the following day the outline of the fry could be seen. Hatching began on the 9th and was completed on the 10th. It was estimated from 600 to 800 fry were hatched. The yolk sac had all been absorbed by the 23rd. They rose from the tray that morning and continued to maintain themselves as free swimmers thenceforth. Beef heart was passed several times through an Enterprise chopper and then rubbed through a cheesecloth screen. Water was added to make a thin soupy solution. This was spread over the surface of the water by the use of a feather. The fry rose to it at once and took it greedily. On April 9 they were delivered to an applicant, being in all 394 advance fry.

In collecting advance fry for shipment advantage is taken of the protective instinct of the male. He seems to realize that by steering the fry near the shore he has only one side of the school to protect from enemies. Close observation is kept on the movements of the school and as soon as they are old enough a cast-net is thrown over them and the entire school, if possible, brought out. The ponds should be carefully watched to locate schools before they disperse, as a few fingerling bass can destroy an entire school of advance fry in a short time. Proof of this was furnished by a number 2 fingerling during the spring of 1922. A school of advance fry were caught up and placed in a trough for shipment. This fingerling was found among them with a very much distended stomach. He was opened up and found to contain 27 advance fry. Several of these were digested, except the head, but with most of them the process of digestion was only beginning. The loss through cannibalism among fingerlings is far in excess of that of adults. This shows the necessity of keeping in close touch with the development of the fry, removing them for shipment before they reach the fingerling stage.

Sunfish, warmouth and crappie do not begin spawning as early as bass. The fry are more susceptible to injury by the net, and are more easily overcome with the heat. Hence, they can not be successfully handled for shipment during hot weather. They are left to be distributed during Octo-

ber and November in connection with the residue of bass collected when the ponds are drawn for cleaning. There is, apparently, no cannibalism among these species.

After the young fish are taken from the pond with the seine the tub in which they are carried is placed under a half inch bibcock to equalize the temperature after which they are transferred to a trough. From there they are counted and placed in the transportation cans. If the shipment is intended for an early morning train the cans, covered with a bobinet screen are set under a 2 inch pipe which supplies water to the cans through half inch bibcocks and they are held thus till time to load them for shipment next morning.

All bass shipped to one applicant for planting in the same pond should be the same size. When fry and fingerlings are planted together the chances are ten to one the fry will become food for the fingerlings. Plants should be made in shallow water containing suitable pond vegetation in which they may find an avenue of escape from enemies and where the food supply is more plentiful. When young fish are planted in a new pond containing no vegetation they should be fed on finely chopped beef heart two or three times each week. Suitable pond mosses should be set in a new pond as the water in turned in for the first time.

The number of fish shipped in a transportation can depends on the size of the fish. 1,000 advance fry, 600 No.1 fingerlings, or 200 No. 2 fingerlings per can have given the best results in shipments from this station. If the cans are overloaded there is considerable loss of fish and those surviving the trip are in a weakened condition. Having lost the disposition to search for food they consequently die of starvation. Every possible effort should be put forth to deliver the fish to the applicant in first-class condition, as this is the chief end and aim of propagation.

A change of method in some features of the distribution inaugurated during the early part of the fiscal year 1922 has resulted in a reduction of the cost of more than 50 per cent during the last two years, as compared with former years. During the fiscal year 1921, under the old method, the average cost per thousand for distributing the fish from the Orangeburg station was $5.60. Under the new method the cost was $1.93 per thousand in 1922, and $1.99 in 1923. The method consists in sending a messenger with fish to a central railroad point with instructions to ship from various points enroute to applicant living on connecting lines, in care of the train baggageman, or by express. On arrival at his

destination he will ship in the same way to applicants living on lines diverging from this central point. A case in point was that of a messenger sent from Orangeburg to Fayetteville, North Carolina. He carried fish for 17 applicants. At Florence, South Carolina, a shipment was made to three applicants living on a connecting line between Florence and Wilmington, North Carolina. Arriving at Fayetteville shipments were made to eight applicants on various lines diverging from that point. The messenger returned to Orangeburg at 11:00 P. M. the same day, whereas, if he had gone to all points and made personal deliveries it would have required at least two days time and would have more than doubled the cost beside the inconvenience and hardship of holding most of the fish over night. It is important that the fish be turned over to the baggageman, or expressman, in first-class condition with proper instructions as to their care enroute. Baggagemen generally have taken a decided interest in rendering assistance in this work and very little complaint has been heard from applicants in regard to the condition of the fish received.

Discussion.

MR. BULLER: Pennsylvania, as you gentlemen probably know, has more pollution in its streams than any State in the Union, owing to its vast mining interests and its large number of industrial plants. The area of Pennsylvania is about 48,000 square miles. Up to the year 1923 these matters were vested in the Department of Fisheries so far as industrial and mining wastes were concerned, and under the Department of Health were placed matters pertaining to sewage. This matter of pollution has been a nightmare to the Commissioner of Fisheries. Year after year articles have been published on the front pages of prominent newspapers of the state; in ninety-five cases out of one hundred unjust criticism was offered by people who never went to the trouble of studying the situation and getting the facts. We have been working conscientiously every year with a view to remedying this condition as far as possible, in many instances with a great deal of success. But no matter how successful we were in effecting improvements in certain streams, the newspapers of the state made no references to these circumstances, there were never any words of praise on their part in connection with what had been accomplished. This, in my judgment, is the most serious question confronting the people of the United States to-day, and it is one that we are to find very difficult of solution. It involves not only

the conservation of the fish but the health of the general public, particularly those connected with manufactures, railroads and mines. In a great many states there is considerable agitation to-day in regard to this matter. We elected as Governor of Pennsylvania one of the foremost conservationists in the world, Mr. Pinchot, and under his administration there has been a reorganization of the State Government officer in connection with the question of the pollution of streams. The powers formerly vested in the Department of Fisheries and in the Department of Health are now vested in what is called a Sanitary Water Board, composed of the Chairman of the Public Service Commission of the State, the Attorney General, the secretary of Health, the secretary of Forests and Waters and the Commissioner of Fisheries. We have outlined a definite policy in Pennsylvania relative to stream pollution and the Department of Fisheries is at present engaged in making a complete survey of all the waters of the State. This survey is being made under the direction of the Commissioner of Fisheries by sanitary engineers, who, working with maps which cover the whole state, are traversing the banks of these streams on foot and making a complete survey as to the pollution. While we have many thousands of miles of streams that are badly polluted, we also have many miles of waters which are yet in their pure state. It is the policy of this Board, in making this survey, to place all streams that are not already polluted in class "A", and to insure that the purity of these streams is preserved, no manufacturer will be allowed to erect a plant along their banks and pollute the waters, nor will there be any mines opened on that watershed. There has also been created a Board called the Water and Power Resource Board, and these two Boards are working in conjunction with each other. The Water and Power Resource Board has authority over the construction of all dams in the state of Pennsylvania, irrespective of their size. It is composed of the Secretary of Forests and Waters, who is the Chairman; the Secretary of Health, the Attorney-General, and a competent consulting engineer appointed by the Governor, and the Commissioner of Fisheries. A resolution was passed by that Board, on my recommendation, at the last meeting providing that no permit shall be granted to any person or corporation impounding waters in the state of Pennsylvania for manufacturing or power purposes unless they permit the public to fish legally in those waters. This provision is going to open up a large body of water in our state for recreational purposes.

The survey to which I have referred will also disclose to what extent some of the streams are partly polluted but not to such an extent that they cannot be remedied without placing too much hardship upon the manufacturers who have their plants on the banks of those streams. It is the policy of the Board to co-operate with the manufacturers and, with the assistance and advice of its sanitary engineers, to attempt to remedy these conditions as far as possible. These partly polluted streams will be placed in class "B".

Then, we have another class of stream which will be known as class "C" streams. To illustrate that class I will take the Lackawanna

River. This river rises in the northeastern part of the State, in the Susquehanna watershed; it is a beautiful stream for a distance of about twenty miles until it strikes the anthracite coal regions at Forest City, and from Forest City to Pittston, a distance of about thirty miles, there is one mine operation after another; it is said that even a typhoid germ will not live in that section of the river. The courts of Pennsylvania in 1825 unfortunately rendered a decision favorable to the mine operator which has caused a great deal of the present trouble in relation to the streams that mine water flows into. In this case, known as Sanderson vs. the Pennsylvania Coal Company, the facts were that Mr. Sanderson has a dwelling alongside the Lackawanna River; in his yard was a fountain containing goldfish; when the mine operations commenced the water in the river became so acid that as it flowed through the fountain it killed the goldfish; and on this account Mr. Sanderson brought action against the company. The Supreme Court of Pennsylvania decided in that case that the mine operator had the right to flow that water into the stream, irrespective of anyone's private rights below. I have spoken to a great many judges on that question, and they have agreed that the decision was a very unfortunate one; had it been given in opposite terms, all these difficulties could have been foreseen and steps taken to obviate them. There is now before the courts of Pennsylvania a case on which this Board is anxiously awaiting decision, known as the Mountainside Water Company et al vs. the Sagamore Coal Company et al. It was a case brought in the Fayette County Court, as effecting not private interests but public interests, and it was argued in the Fayette court by thirty-six of the most prominent attorneys of the State of Pennsylvania. The decision of the Fayette County Court was against the Water Company; it is now before the Supreme Court, and we are awaiting with much interest the decision of the Supreme court, in view of the fact that the case is brought as affecting the public interest. This case involves a $25,000,000 water project of the Pennsylvania Railroad Company; so that in the case of class "C" streams, we are advising all those who are complaining that we will take no action until we learn of the decision of the Supreme court with regard to mining streams. I may say that we have provided that everyone who makes a complaint about the pollution of streams and the killing of fish must make it in the form of a sworn complaint, or we will pay no attention to it.

PRESIDENT LEACH: I only wish that more States would take the interest in this matter that Pennsylvania is now taking.

MR. BULLER: I would like to know what some of the other states are doing. It is a question that involves a great deal in the work of conservation.

MR. DOZE: What is being done about oil pollution?

MR. BULLER: I think that is a matter that will be taken up in the meeting of the commissioners which is to follow this.

MR. DOZE: We have that problem to meet in our state. The question is, what are we going to do with the water that is polluted? It has

to reach the sea level. This question came up in Kansas in connection with our oil wells, and in any action that is brought we will be beaten every time because that water has to find its way to the sea level, and the only way you can do that is through the streams. We do not want to make a laughing stock of ourselves by being too severe toward the industrial plants which are located along streams. In one of our counties which is about the size of the State of Delaware, the result of the striking of oil was the destruction of one of the finest black bass streams in the United States; there was no way of getting the water out except through that stream. If you bring action in these cases, you are asked: "What are you going to do with this stuff? It has to have an outlet, and even if it is not put directly into the streams it will find its way there through the subterranean sands or strata." We will not get anywhere by simply saying to people, "You must not do this," because the development of the nation requires that we open our coal mines and drill for oil. The problem of oil pollution is of vital interest to me. I have had some correspondence with the gentleman from Pennsylvania on the subject, and I intend to go down there and see what his methods are of handling the problem. I think this Society ought to hear him on how he is handling the oil situation.

MR. HARE: We have a chemist in the room, and I would like to ask him if it would not be possible to use every by-product that results from the operations of these various manufacturing concerns. Have we not a scientist who is competent to work it out on that basis?

PRESIDENT LEACH: I think I could answer that question by saying that all the large manufacturing concerns of this country have their own chemists and that they are utilizing their waste products as far as possible. For instance, the Dupont Company used to make powder only; now they make something like two or three hundred different by products; these have become the main product of the plant, and powder has become a by-product. Most of the large companies are doing the same thing. It is only a matter of working these things out. Some of the companies feel that they are not able to afford the necessary changes of machinery and equipment involved in the utilization of these by-products, particularly when there would be some doubt as to the possibility of selling them even when they were ready for the market.

MR. HART: I understand that they have a fine Sanitary Board in Rhode Island which is giving attention to these matters. Is there a man from Rhode Island in the room?

PRESIDENT LEACH: I do not think there is a representative from Rhode Island present. This question of pollution is a very important one, but we are depending upon the meeting which will convene after ours to thresh that out. The Bureau of Fisheries is very much interested in it, because it has a large bearing upon our work. We are glad that Pennsylvania and some of the other states are tackling these problems.

PLANTING EYED SALMON AND TROUT EGGS.

By C. W. Harrison,
District Inspector of Hatcheries for British Columbia,
Vancouver, B. C.

For many years fish culturists have been attempting to devise ways of planting, in their natural environment, the eggs of fish artificially spawned. Particularly this has been the case with salmon and trout eggs, and though several methods have been tried, they have not met with unqualified success: the faults in them have been obvious to those engaged in the propagation of fish life.

One of the methods employed, particularly in Great Britain, has been the screening off of sections of natural spawning grounds and then scattering the eggs in these enclosed areas. But the loss through exposure to sunlight, natural enemies and through eggs which failed to lodge in crevasses in these partly protected areas being washed down stream, made popular acceptance of this method impossible. Another method was to construct boxes in the streams and place therein layers of gravel and eggs through which the necessary amount of water was allowed to circulate. This system, though successful in hatching the eggs, was so limited in its application that the wide distribution of ova—at which egg planting principally aims—was far beyond its scope.

The method described below has overcome all objectionable features which apply to these artifices mentioned and has for three years been employed in British Columbia by the Department of Marine and Fisheries of Canada with a large degree of success.

Three years ago it was found necessary for the writer to proceed to an unsettled and isolated portion of the northern British Columbia Coast with a view to rehabilitating certain streams which had become depleted of sockeye salmon and to use for this purpose eyed sockeye eggs which were to be planted in gravel under as natural conditions as possible. The district to be seeded was many miles from a settlement and conditions demanded that a speedy and inexpensive means of distribution be employed. Planting in gravel on the natural spawning grounds was the only way open and although this work had been attempted before by various means, on an experimental scale, the nature of the district and the shortage of local material precluded the use of any

of these. Since the transportation of cumbersome equipment was out of the question, it was necessary to invent some new mobile apparatus capable of being handled by a small number of men. The egg planting box described in this report was the result.

The first plantings were made in a small way. Extensive and repeated experiments were tried with it until, last year the Department of Marine and Fisheries, being thoroughly satisfied with the feasibility of the plan, a total of 22,000,000 eyed eggs were planted with it in outlaying sections of the Province, far from localities covered by hatcheries. In this Province when planting trout eggs where not more than one hundred to five hundred eggs are deposited in one planting, a box 18″ or 20″ in length with other dimensions in proportion, is used.

Considerable improvements in the design and attachments have been made, one of which was the elimination of the hinged door on the top, and again, the fasteners for the bottom shutters were replaced by a much simpler fastener.

Under existing conditions in British Columbia, the planting of eyed eggs in outlying districts is the only feasible method whereby many extensive and important spawning grounds can be stocked. A great number of these grounds are so far removed from existing hatcheries that it is quite out of the question to stock them with fry. The planting of eyed eggs is the only method that remains and the Harrison Box has proved to be the most efficient device so far developed to meet all the conditions liable to occur.

In experimental work it has been found that the best results cannot be expected unless the eggs are deposited under almost natural conditions, on no account must the plantings be completely surrounded by small-meshed wire screening. To determine the numbers of fry hatched out from any given quantity of eggs planted, a narrow spring fed creek which is not subject to freshets and containing a clean, loose gravel bed is the most suitable. Screens may be placed completely across the stream at intervals of about 20 feet one planting being made in each of these sections. The screens must be properly placed and kept perfectly clean to ensure thorough circulation of water. Conditions such as these have been found to give good results and the resultant fry can be accurately counted.

When undertaking extensive seeding of natural spawning grounds the man in charge of the egg planting operations should first select portions of any stream where conditions are as nearly as possible identical with others where it has been noted that parent fish naturally prefer to deposit

their eggs. In this province most satisfactory locations are at points where clean loose gravel is to be found, ranging in size from ½" to 2" in diameter. He should then have channels dug in the bed of the stream of sufficient length and width to accommodate the planting box. These channels should be about 5' in length and 2' in width, lying lengthwise up and down stream with a depth in the gravel about the same as that of the box. Care should be taken to ensure that all plantings will be covered with water at all times during incubation, thus a knowledge of what will be the extreme stage of low water should be obtained and allowance made accordingly.

In loading the box it is necessary that the gravel used should be well washed, to clean out all silt and mud. This is usually done by turning it over a few times at the edge of the stream so that it is thoroughly cleansed by the running water flowing through it. It is then placed in a heap in close proximity to the place where the box will be loaded. Where large numbers of eggs are going to be planted the above is the proper method to follow but where small plantings are to be made it is advisable to wash and screen the gravel thus eliminating all silt, sand and mud.

The men in charge should arrange for the loading of the box at a point as near as possible to the area where the eggs are to be planted and a suitable stool should be provided to keep the box clear of the water at a convenient height for filling.

The method of loading the box is as follows: Place about 2" of gravel over the bottom of the box, then carefully scatter eggs on the surface of the gravel, taking great care to handle the eggs gently. The eggs will roll into the interstices of the gravel. Over this carefully place a covering of gravel, care being taken that the eggs receive no jar or ill usage. Continue to introduce alternately eggs and gravel to within about 4" of the top of the box. The remaining space should be filled with fairly even-sized, clean gravel. The box is then lifted and placed in one of the channels previously prepared in the bed of the stream. Both sides are banked with gravel to the full height of the box. Next insert the long handled hook provided for the purpose, in the iron ring in the center of one of the bottom shutters and draw it clear of the box. Directly the shutter is withdrawn, bank up that end. The same procedure is followed with the other shutter. It is advisable to first withdraw the shutter and bank up the gravel at the upstream end, thus preventing the eggs from being scoured out when the down stream shutter is taken out. The contents will now be lying in the

bed of the stream confined in a bottomless box. Two men, one at each end, now take hold of the handles and slowly lift the box clear of the water, which leaves all eggs in the bed of the stream under the same conditions as if deposited naturally by parent fish. The quantity of eggs deposited at each planting should be nearer 3,000 than 5,000; the eggs should be well eyed, but not too near the point of hatching.

As stated in a previous paragraph, the first plantings were confined to small numbers of eggs but as the value of the new method became recognized, the Department authorized the planting of increased numbers.

From the collection of 1920, 750,000 eyed sockeye eggs were deposited on natural spawning grounds by this method. From the collection of 1921, the number of eggs thus planted was increased to about 16,000,000 and from the collection of 1922, 22,000,000 eggs were distributed by this system. The distribution from the 1922 collection includes about 1,500,000 trout eggs and 200,000 Atlantic salmon eggs.

All reports go to show that the results were eminently satisfactory.

A number of experimental plantings conducted by the superintendents of various hatcheries in the Province are described.

At the New Westminster Hatchery on February 26th, 1921, one thousand eyed sockeye eggs were planted by this method in a waste ditch in the immediate vicinity of the retaining ponds. The Superintendent reports that when the free-swimming fry left the gravel, 807 healthy, vigorous fry were counted.

The Superintendent of the Cultus Lake Hatchery, in connection with experimental plantings, reports as follow:

"Almost a month after the eggs of the same age held in the hatchery baskets had become free-swimming, the fry began to appear from the gravel, those from a nest of coarse gravel were the first to make their appearance. From the very beginning the fry were wild and undoubtedly more wary than those incubated in the hatchery.

The results are set down in the following table:

No. planted	Description of nest	No. Hatched.
500	Gravel from size of pea to hickory nut—some clean sand.	350
500	Same as above with top coating of silt—½ inch deep.	325
500	Fine gravel sand and small amount of clay in sand.	200

500	Fine gravel and much clay or mud in sand.	170
500	Gravel from size of hickory nut to walnut, very little sand, no clay or top covering of silt.	420

In continuation he expresses the opinion that the alertness of the gravel-hatched fish is a factor worthy of consideration when estimating the relative chances of survival of these and hatchery-reared fry.

One hundred cohoe salmon eggs were planted in coarse clean gravel, within an hour after the parent fish were stripped. Seventy-five fry hatched in healthy condition.

The following plantings of sockeye eggs were made during the past season at the Harrison Lake Hatchery by means of the Harrison Planting box:

Planting	No. of eggs planted	No. of resultant fry.
No. 1	500	456
No. 2	500	420
No. 3	500	407
No. 4	500	200
No. 5	500	401

The superintendent reports that there was a hole in the screen of No. 4 and fry escaped which were not counted.

Two plantings of green eggs in gravel were also made, in one case with soft and in the other with hardened eggs, with the following results:

1,000 soft green eggs produced 350 fry

1,000 water-hardened eggs produced 400 fry

Altogether at this hatchery 300,000 sockeye eggs were planted in gravel in the vicinity of the hatchery last fall, including the experimental plantings mentioned above. The superintendent reports that the results of these plantings have been good. Careful watch was kept and large numbers of young sockeye resulting from the plantings were seen. The plantings at Morris Creek amounting to 1,413,000 eyed eggs also turned out very well. This point was inspected and great quantities of sockeye fry were later observed in the creek.

On January 29th, 1923, three plantings of eyed spring salmon eggs were made in Oliver Creek near the Cowichan Lake Hatchery—500 in each planting, with the following results:

Planting No. 1 — 437 fry.
" 2 — 465 "
" 3 — 476 "

Again on January 30th two plantings of eyed eggs—500 each—were made in the same creek, which produced:

Planting No. 1 — 482 fry.
Planting No. 2 — 463 "

In 1922 the Superintendent of the Rivers Inlet Hatchery made five plantings each containing 500 carefully counted eyed sockeye eggs. He reports as follows:

"In the first pond the gravel was coarse and the eggs planted about six inches deep. Three hundred and eighty-seven fry came out of the gravel.

In the second pond the gravel was finer and the eggs planted about 6 inches deep. One hundred and thirty-seven fry were counted.

In the third pond the gravel was about the same as in the second pond and the eggs planted about 2" deep. Four hundred and ninety fry were counted.

In the fourth pond the gravel was very fine, practically all sand and the eggs were planted about 2" deep. A small hole was found in the screening so no doubt some fry escaped. Two hundred and thirty-seven fry were counted.

In the fifth pond the gravel was very fine and the eggs were planted 8" deep. Only 7 fry made their way out of the gravel. These seven were much larger and stronger than the fry hatched in the baskets in the hatchery or the fry that came out of the gravel in the other four plantings. Apparently only the very strongest fry were able to make their way out of the very fine gravel when planted that deep.

In plantings of this nature the eggs and fry do not have the same advantages as they would if not screened and in a creek bed. The screening around the plantings gets clogged up and prevents not only the surface water but also the circulation of water through the gravel, which no doubt is a great help to the fry when they are trying to make their way to the surface."

The Superintendent of the Anderson Lake Hatchery, Vancouver Island, reports that he made four plantings each containing 500 eyed sockeye eggs and the resultant fry, accurately counted, were as follows:

No. 1 planting	487 fry.
No. 2 "	475 "
No. 3 "	455 "
No. 4 "	448 "

In 1922 about two million sockeye eggs were planted in Great Central Lake, Vancouver Island, and during the summer of the same year large schools of fry were observed in these waters by residents in the locality. Early this spring

employees of the Department operated fyke-net at the outlet of the lake at the time the yearling sockeye were expected to migrate to salt water. A number of well proportioned sockeye yearlings were captured and specimens forwarded to the Department. These yearlings undoubtedly were the result of egg planting as, owing to that impassable obstruction, Stamp Falls, no returning parent fish of this variety were ever known to reach Great Central Lake.

The Superintendent of the Pitt Lake Hatchery reports that in January, 1922, he made two plantings of eyed sockeye eggs in one of the retaining ponds operated in connection with that station, each planting containing 1,000 eggs. An accurate count showed that the number of fry emerging from these plantings was 1940, indicating a loss of only 60 from the 2,000 eggs deposited.

Other successful experiments might be cited but those described above are sufficient to prove that this system has an important place in future fish cultural operations.

The advantages to be derived from this method are apparent to every fish culturist whose work is carried on in a thinly populated country where means of transportation are still of a very primitive nature. One man can carry an egg planting box lashed to a Yukon pack board; a second can carry 100,000 eggs, and one or two others the shovels, and so work their way up or down salmon rivers or creeks, planting a tray here and a tray there—wherever conditions are suitable. A wide distribution can thus be made. This work has been done in this Province in the late fall as well as in the early spring when the rivers first open and the planting team have had to work from stream to stream on snow-shoes. It has been carried on from a fishery patrol boat travelling from cove to cove up the north coast stopping at the nearest point to many of the innumerable short spawning streams. In the latter case the team with extra men to carry whatever additional boxes containing eggs were needed, left the boat at dawn, pushed inland to previously selected spawning grounds, and were back to the boat by night. Eyed eggs properly cared for, have been held on board the boat in shipping boxes for one month without any loss whatever, so that scores of miles of coast line can, and have been covered in a single cruise.

These plantings along the coast can be made at whatever time during the winter or spring the eggs are at the required stage of development, but those made in the interior of this Province, where severe winter conditions prevail, must be completed either before the freeze-up or as soon as the streams are open in the early spring. In the case of fall

plantings, to guard against frost during low water, the nests are placed as near as possible to the foot or head of riffles which give a more rapid circulation of water. In this kind of planting, the box is set deeper in the gravel so that the top of the nest is flush with the creek bed; but in the spring when danger of frost and freshets is past and incubation is more rapid, the plantings are made shallower, only part of the nest being below the level of the stream bed, and the rest in a flat mound through which the water circulates freely. In this as in every other phase of this work a thorough acquaintance with local conditions is imperative.

This method of distribution is not necessarily confined to fish of purely commercial value. Last spring 200,000 Atlantic salmon eggs were distributed in this way, in streams tributary to Great Central and Sproat Lake, on the west coast of Vancouver Island, and plantings of cutthroat and Kamloops trout eyed eggs were made at widely separated points in many parts of the Province. The majority of these places would have been impossible to reach and stock with free-swimming fry or fingerlings. In almost every case splendid results have been reported.

To facilitate the planting of sporting fish eggs, the writer is now perfecting a one man outfit. This consists of a smaller box, a shovel after the fashion of an army entrenching tool and a light box for the trays, which is nested inside the planting box while being carried. The carrying can be done by means of shoulder straps attached to the box. With this equipment, one man can make an almost ideal distribution, planting small lots of one hundred to five hundred eggs in suitable places over a wide area.

At one of the Canadian Government hatcheries at Cultus Lake, experiments are being made in planting green eggs directly after they are water-hardened. The results so far obtained were as follows:

On December 10th, 1922, two female cohoes were spawned in separate pans, the eggs fertilized and allowed to stand for 40 minutes in water at a temperature of 34 deg.F. These eggs were then planted by the Harrison Box method in two streamlets at the hatchery. On February 28th of the present year planting No. 1 was examined, and on March 27th an examination was made of planting No.2 with the following results:

Of the 637 eggs shown as fertile in planting No. 2 six eggs when being picked up had the appearance of being alive, but were found on subsequent examination to be infertile. It will be noted that these are not included in the column headed "Bad Eggs."

If this is found to be workable generally, a new and hitherto unconsidered saving can be effected and great natural wastage of seed prevented. One instance selected from several of which the writer is aware will illustrate this:

In Fifteen Mile Creek a tributary to Babine Lake in the northern interior of the Province, there is a limited spawning erea not more than a quarter of a mile in length, yet annually approximately 12,000 to 15,000 parent sockeye gather off the mouth of this stream. When the first fish are ripe they leave the large school and run up to spawn. Succeeding runs enter the creek and in making their rudds, turn up the eggs of the first spawners within a short time after they have been deposited. This continues for several weeks and finally only the eggs of the last run are left to develop, unmolested. The wastage is enormous and behind sunken logs or boulders it is possible to scoop up immense quantities of eggs which have been turned out of gravel and killed while in a delicate stage of development by the later running fish. This loss is tremendous and undoubtedly the eggs destroyed would be sufficient to fill a small hatchery to capacity.

When a sure method of planting water-hardened eggs is perfected, as the writer is confident it will be, a spawning camp can be located at the mouth of this creek, all eggs taken as the parent fish become ripe and the spawning ground abundantly seeded by this method. The surplus eggs which otherwise would be lost will then be available for transportation to other creeks in the district where the runs are negligible, and planted there by means of the Harrison planting box. What this saving would be, applied to many other streams in this Province, where similar conditions exist, the reader can well imagine.

In conclusion, the writer feels the need of reiterating his statement that the successful development of this work depends to a very great extent on the fish culturist's knowledge of his district and the various natural conditions that prevail.

Discussion.

PRESIDENT LEACH: This is a very interesting paper, particularly so to those parts of the country where it is found necessary to plant eyed eggs in more or less inaccessible waters. It is also of great importance to those whe find it necessary to plant surplus eggs, and I am sure that a close study of this paper after it is printed will reveal to you methods

by which you can greatly improve your present work. Are there any remarks on this paper?

MR. CULLER: The Bureau of Fisheries planted quite a few eyed eggs in Yellowstone Park this summer, and I fully agree with what Mr. Harrison says in regard to the feasibility of the plan. As to the apparatus used, that is merely a question of opinion among fish culturists; the main idea is to have as simple apparatus as possible. Depth is another matter of opinion; nothing has been decided in regard to it. Experiments show that where there is fine gravel, sand, silt and clay, the work is not successful, and for my part I would use a little larger gravel where the plants are made than he used in his experiments.

BLACK BASS VERSUS NETTING OF COARSE FISH.

By J. P. Snyder,

U. S. Fisheries Station, Cape Vincent, N. Y.

What effect in general does the netting of coarse fish in the early spring before bass spawn and in the late fall after bass leave the shoal waters have upon the abundance of black bass? This is a local question coming up again and again in the vicinity of Cape Vincent, New York, situated at the junction of the St. Lawrence River with Lake Ontario. Since this question undoubtedly comes up from time to time all over this country where people are deeply interested in bass fishing the writer feels justified in bringing it to the attention of this society hoping it will provoke discussion and be helpful to those who are frequently called upon to answer the question. To the inhabitants of many of our tourist villages along Lake Ontario and the St. Lawrence River the correct solution of this question is of vital importance and doubtless this is true of communities in many other states and in many of the provinces north of us. The writer refers to it as a vital question because the prosperity, in fact the very life of many of our lake and river shore villages is dependent upon good bass fishing that draws its devotees from all parts of this country and from every walk in life. Many millions of dollars are invested in boardinghouse and hotel property maintained for the convenience and comfort of men and women who enjoy the exhilarating thrill and sport of catching black bass. Many hundreds of thousands of dollars are also invested in boats and equipment for their accommodation, and employment is given to thousands of men who act as guides in conducting these summer visitors to various fishing grounds. Even the catching of bait for all these thousands of bass fishermen is no insignificant source of employment and revenue. The revenue derived from the people who annually visit Lake Ontario and the St. Lawrence River runs into many hundreds of thousands of dollars and it is the lure of black bass more than any other one thing that impels them to come again and again and to stay as long as they can. Poor bass fishing is immediately reflected in the attendance at our hotels, boarding houses and tourist camps. Take away our bass fishing or destroy it to such an extent that it is no longer attractive to our summer

people and you take away the livelihood of thousands of our citizens and destroy millions of dollars worth of property.

But we have another class or group of people who are not dependent on bass or on bass fishermen for their livelihood. I refer to our commercial fishermen or net fishermen. Here also we have an industry that gives employment to hundreds of people and many tons of good food to thousands of people. Both industries are necessary to the prosperity of many of our villages. Both are legitimate, proper, worthwhile and should be encouraged. The one directly brings rest and health to tired bodies and fagged brains, gives a new appreciation of the great outdoors, and directly and indirectly gives employment to thousands of our people. The other gives employment to hundreds of men, cheap and healthful food to thousands of people and investment to hundreds of thousands of dollars. The question arises, are these two industries necessarily antagonistic to each other? Are they fundamentally such that they cannot be harmonized? Many think they are. Many think it possible to harmonize them. Others think it may even be possible to so fit them together that they will be helpful to each other. The writer is not qualified to attempt to answer these questions. He simply happens to be employed where these questions come up from time to time, and since his work deals with fish those interested in fish often seek his guidance. In the vicinity of Cape Vincent there seems to be no conflict of opinion as to the use of nets in taking non-game fish except when the nets are set in the St. Lawrence River or along the lake shore and its indentations. In the open water of the lake a mile or more from shore there is no objection to the use of nets in taking fish. It is only when these nets are set along the shore, or in bays, or rivers or interior lakes that objection is made and here even the net fishermen concede no nets should be set while bass are spawning or during the warm summer months when bass entering the nets would be likely to be injured and die. The question then becomes limited to their use in the early spring and late fall. At Cape Vincent it centers around early spring netting along the lake shore before bass spawn and that seems to be the most practicable time to catch coarse or non game fish such as yellow perch, pike perch, pickerel, suckers, ling, sunfishes, carp, bullheads, eels, etc. Nearly every man you meet has rather pronounced views as to the advantages or disadvantages of spring netting of these so-called coarse fish and some men on both sides are so convinced as to the correctness of their views that they give freely of their

time and money to any effort to give effect to their views. Unfortunately few, if any of these men who are so positive of the correctness of their views, have given the question any dispassionate thought or careful study. As a result their views are of little or no help in uncovering the truth. However as this question has come up again and again all along the Great Lakes and at many smaller lakes and along many rivers and bays it seems that out of all this discussion something fixed, clear, definite, secure, should come. It is this something fixed and safe that the writer wants. Many factors necessarily enter into the solution of this question. Many of these factors belong to a field in which the writer regrets he is not qualified to enter, a field belonging to those having a scientific education and training and a love or passion for research work, but so general and wide-spread is the interest in this question and so vital in its correct soluton and applicaton to so many people that it seems somewhere there must be trained men who are giving or have given it careful study. If there are any of these men present at this meeting it is to them that the writer appeals. Among the factors entering into the correct solution of the question the writer takes the liberty to mention the following:

1st—To what extent are we justified in spring netting of coarse fish because of their commercial value to the net fishermen and their food value to our people? Undoubtedly this phase of the question deserves careful consideration. The writer understands that in a restricted disputed area in the vicinity of Cape Vincent last spring over 60,000 pounds of coarse fish were taken in nets and sold for food. The food value of these fish was doubtless equal or greater than the food value of all the bass taken throughout the year from these same restricted waters. During the spring of 1918 when netting of coarse fish was permitted in the St. Lawrence River hundreds of thousands of pounds of coarse fish were taken and sold for food. This being true we cannot ignore the food value of these coarse fish and we seem unable to get them in large numbers except by netting. Netting is most effective in catching them in shallow water in the early spring during their migration to shoal water to spawn.

2nd—What effect does the removal of these coarse fish have upon mature bass? We know that at least in some measure small suckers, perch, bullheads, etc., serve as food for mature bass and for bass fingerlings. Doubtless the extent to which this is true varies greatly in different waters but Lake Ontario and the St. Lawrence River seem to be well

stocked with many species of minnows, crawfish and other natural foods for adult bass. In fact so abundant are these foods that we often hear bass fishermen attribute poor bass fishing to the abundance of minnows, etc. Are we then to conserve these coarse fish because they in some measure at least enter into the food of bass? Because of this are we justified in outlawing spring netting of non game fish with its accompanying results—the denial of employment and revenue to netters and many thousands of pounds of cheap food to our people? Here is food for careful thought and study.

3rd—To what extent does spring netting of coarse fish conserve the eggs of bass? Herein many bass fishermen lay all their troubles to German carp, believing that carp destroy the eggs of bass. What do our pond men say as to this? It seems this phase of the question could be solved by putting German carp in bass ponds and observing what takes place. Personally the writer has never seen carp eating the eggs of bass except in cases where the parent bass had been killed or driven away from its nest. The writer is satisfied however from what reliable men have told him that eels are destructive to bass eggs. They tell him that the silver eel is one species of fish that brood bass seem unable to drive away from their nests, that again and again they have seen eels eating the eggs of bass. They also tell him that suckers operating in schools are destructive to bass eggs. Are we therefore justified in removing coarse fish from bass waters because some of them at least at times eat bass eggs?

4th—To what extent if any does spring netting of coarse fish conserve bass fry and fingerlings? With us on the eastern end of Lake Ontario suckers, carp, perch pike, pickerel, bullheads, etc., all seek the shoal waters in which bass later spawn. We know they spawn earlier than do bass, that their eggs hatch earlier than bass eggs do, and that their fry feed earlier. This being true to what extent do these millions of little perch, pickerel, pike, etc., feed upon bass fry, and particularly to what extent do they feed upon the natural food of bass fry? Since the fry of these coarse fish feed earlier than do bass fry they may be tremendously destructive to bass fry by cutting down their available food supply. The writer believes it is generally conceded that the capacity of any body of water to produce fish is largely influenced by its capacity to produce fish food. To the writer this phase of the question deserves careful consideration. The importance of this was brought forcibly to his attention some years ago by an experience he

had at Cape Vincent. A few miles from the station there is a depression on an island that fills up with water during the early spring forming a pond of one or more acres. In the late summer this pond dries up and weeds and grasses grow all over the pond bed. Some years ago in May the writer put 100,000 yellow perch fry in this temporary pond intending to remove them later before the pond dried up. At the time the perch were introduced the pond was simply teeming with minute aquatic animal life. By the middle of June these baby perch ranged from half an inch to one inch in length averaging about three fourths of an inch in length. They were plump and well rounded and it seemed that every one had survived but by that time they had exterminated the food in the pond. A week later they were emaciated and turned cannibals and in a few days they actually cut their numbers down to about twenty thousand. Hundreds and hundreds of these perch were seen eating their weaker brothers. This was about the time with us when bass fry were just beginning to take food. The question arises what possible chance would bass fry have had in that pond at that time? It is true this was a pond in which conditions were intensified but in open waters of the lake and river teeming with millions of perch, pickerel, pike, bullheads, sunfishes, carp, suckers, etc., where each spring these fish deposit untold millions of eggs and later where the shore line and bays teem with hordes of their young before bass fry need food isn't there something of this same tragedy effected? What chance have bass fry where these conditions exist? The writer has seen myriads of baby perch, bullheads, sunfishes, etc., along the lake shore and in the shallow waters of the lake indentations prior to the advent of bass fry and it seemed to him that these myriads of little perch and other fishes must surely seriously cut down the food supply available for baby bass. We all know the cannibalistic tragedies that take place when baby bass get hungry. It has been quite a few years since the writer handled bass in ponds and doubtless many careful observations and much progress has been made in pond work since then but his observations led him to believe that scarcity of food was the one biggest cause of loss of bass fry in ponds. May not the same thing be true of bass fry in the open water of lakes and rivers? If this is true then will taking out coarse brood fish in the early spring before they spawn conserve food for bass fry? At any rate the writer feels that someone having the necessary training and experience should delve into this, that we may have something authentic on which to base our judgments.

If we concede that in general these coarse fish or non game fish should be removed from waters inhabited by bass the question immediately arises as to the best time and most effective method and appliance to be used in removing them. Spearing is not effective in taking all kinds of coarse fish. Gill nets are not recommended because bass entering them are almost certain to be seriously injured. Poundnets are outlawed in Lake Ontario. Fykenets are used in Canadian waters near Cape Vincent. The New York Conservation Commission favors the use of trapnets or so called sunken poundnets and in this the writer concurs. These nets are effecti ve in taking all kinds of fish and they seem to be less injurious to bass that enter them than any other type of net except poundnets and seines.

We have in the vicinity of Cape Vincent certain bays in which no netting of any kind has been permitted for years. In other local bays the use of trapnets in taking coarse fish during the early spring and late fall has been permitted for years until the present year. Across the boundary line of the St. Lawrence River and of Lake Ontario fykenets have long been used in taking coarse fish during the spring and fall and it is worthy of note that it is generally conceded even by those opposed to any netting of any kind that bass fishing has for years been better in those areas where netting has been permitted than elsewhere. For instance more bass were taken by hook and line—the only way they can lawfully be taken—along the north shore of the St. Lawrence River than along the south shore. More bass are taken in Chaumont Bay and around the islands of Grenadier and Fox where netting has long been permitted than are taken in Henderson Bay and Harbor where no netting has been permitted for years. The question naturally arises to what extent, if any, is this condition due to spring netting of coarse fish? The writer does not attempt to answer any of these questions but seeking information brings them to the attention of this society.

FISHERIES IN VIRGINIA.

By McDonald Lee,

Commissioner of Game and Inland Fisheries, Richmond, Va.

It is rather a difficult matter to get the up-country people to understand the value of our fish and oyster industries in Tidewater—to the people of one-fifth of the state directly, and indirectly to the state's tax problem in general. But for these water industries a large part of the Tidewater section would be barren wastes, inhabited only by fiddlers, sand-crabs and buzzards, and of no taxable value to the state at large. It is largely due to this favorable location on water-courses and nature's gifts that the personal and realty values of Tidewater equal or exceed those of other grand divisions of the state. This should be the answer to all criticism of legislators and others when the fish and oyster industries are under discussion. Approximately 16,000 persons are wholly engaged in our water industries, and probably 60,000 more indirectly connected.

Not only does Virginia present in its physical aspect the best haven in area for shipping on the Atlantic coast, but it occupies the central position of ingress and egress both North and South. So much for its great Hampton Roads and the five major rivers, with their splendid tributaries, which feed it and course on to the sea. Our topic at present is nature's material asset there— that of fishes and oysters.

The blue crab of the Chesapeake is really the only commercial crab of importance, and Virginia furnishes the greater part of this product. True Crisfield, Md., on the border, is the center of the soft crab industry, supplied largely from the crags of Pokomoke Sound (wholly within Virginia) and Tangier Sound (largely in our state.) To this Maryland market comes also the soft crab from the Potomac, Rappahannock, York and the Eastern and Western shores of Chesapeake Bay. Hampton, Virginia, is the center of the hard crab market, for according to nature, hard crabs are more abundant in the lower Chesapeake, while soft crabs predominate in the upper Chesapeake. From both Crisfield and Hampton soft and hard crabs are shipped North and West in the raw state, and also canned for transport to California as well as the European markets. The crab industry engages our watermen, and those of Maryland, at

periods when many other fishing industries are not in operation. Fortunately, or unfortunately, water-products rotate in their seasons and watermen in general desert the land the year round.

However, the oyster is the greatest commodity of our water products. While the output in recent years has been approximated around five or six million bushels annually, there was a time when Virginia produced twelve to fifteen million bushels, by far the greatest of any state on the Atlantic coast. The upgrade work in oyster production, which is being resumed since the world war, should in a year or two approximate ten or twelve millions of bushels, and if so the advanced price on oysters will cause the industry to be the most valuable in its record. The cost of oysters has advanced with all other products, largely because of the great increase in demand and the high cost of labor. Norfolk is the largest individual handler of oysters, the dealers there getting their stock from the James River and Hampton Roads points, as well as further up, from the York, Mobjack, Cape Charles and even the Rappahannock, the Potomac and the Sounds.

There are three classes engaged in the oyster business, viz: the tonger or catcher, the planter, the packer. Ofttimes the tonger may be a small planter, and quite frequently the packer is also a planter. Each vying for preferment brings a complex situation in the administration of these affairs. For instance, he who packs and ships, only, is in little accord with the catcher or planter; the planter is often at loggerheads with the catcher, while the catcher is in general opposed to the planting system. These conditions exist only in a general way, for there are many exceptions in each of the classes. The administration of oyster affairs has always sought the best for each class while not infringing upon the privileges or deserts of the other classes. Such a policy, which is for the best good of the greatest number, does not meet with approbation from any of the three classes, since it is human nature to want all for yourself or your business. Nevertheless, conditions in the oyster regions in Virginia today are quite favorable—both as to administration and the prospect for increased output.

Oysters and fish are probably the cheapest of meats when the weight and caloric values are considered. None could be more healthful. It is not hard to estimate that about fifteen millions of dollars of the raw product goes annually from the water industries of Virginia. As said, of this the oyster is the greater portion.

The fin fisheries add much to the income of Virginians. More than six thousand licensed nets are engaged in the commercial industry of fishing, and but for these there would be very few or no fish on the markets. As it is, we have much complaint of the scarcity of fish and against the numerous nets. Year after year these complaints come up, yet the records of many years indicate that there is decrease in but few varieties of our fish, while the total output is constantly increasing.

The demand for fish in Northern markets at high prices induces the catcher to ship North instead of throughout the state, and this unfortunate condition of scarcity in our own markets is brought about by the demand of those who are willing to pay higher prices, and not by scarcity of the fish. While the rivers up the bay teem with commercial as well as game fish, most of these go to Baltimore, Philadelphia and New York. Those of the lower Bay and Hampton Roads center around Norfolk and the Virginia peninsula, Norfolk being the largest market for fin fish even as in oysters. The commerce and trade derived from the water delvers is a great asset to Norfolk and other marts on Hampton Roads.

Periodically, efforts are made to scare the public on the Pollution theory as effecting oysters. Years ago the Federal Government made a terrific crusade on this line, and beggared many thousands of people in the industry, and frightened the general public almost into fits. The campaign, lasting several years, was finally decided before Secretary Houston of the U. S. Department of Agriculture, who declared that the oyster had been greatly wronged. Occasionally there bobs up some department of science that wants to get into the limelight on the same subject and the damage to localities and people is much before it can be dissipated. With the exception of the waters at one or two thickly populated sections of Virginia, our vast area of tidal waters is free of pollution. From those isolated spots alluded to no oysters are allowed to be taken, therefore the product of Virginia is certainly equal if not superior to that of any Atlantic coast state. Competitors North are usually the ones who agitate this pollution idea for the Southern States, because they themselves have been barred in the waters of their populous localities.

THE CONSERVATION OF THE FISHERY RESOURCES OF THE PACIFIC.

By Dr. Barton Warren Evermann

Director of the Museum of the California Academy of Sciences and of the Steinhart Aquarium.

The fishery resources of the Pacific are, chiefly, (1) the fishes proper, such as the salmon, sardine, halibut, cod, herring, albacore and the like; (2) the aquatic fur-bearing animals such as the various species of fur seals and sea otters; (3) the whales and other cetaceans; (4) the species seaweeds.

Before man began to deplete these resources through greed and destructive fishery methods, practically all these species were excessively abundant in various parts of the Pacific. The annual product of these natural resources has, in years past, run into hundreds of millions of dollars.

In the present article attention will be called to only a few of these natural resources.

FUR SEALS

It appears not to be generally known that fur seals were once very abundant on certain islands off the coast of California and Lower California. I have recently looked up some of the old records and I was surprised to find that several of these islands were once the breeding grounds of large herds of fur seals. For example, more than 200,000 fur seals were killed on the Farallons, only a few miles from San Francisco and the Golden Gate, between 1806 and 1813. Many thousands were killed about the same time on or about San Miguel, Santa Cruz, Anacapa, Santa Barbara, San Clemente and San Nicolas islands off the California coast, and still other thousands at the Coronados, Guadalupe, the Benitos Cedros and Natividad off the coast of Lower California.

The total number killed between 1806 and 1820 must have exceeded 400,000. At current prices of fur-seal skins these would be worth more than $20,000,000. The killing was done in the most reckless manner possible, without any regard whatever to the preservation of the species, with

the result that the rookery on the Farallons was entirely wiped out by 1834. Not a single fur seal has been seen on those islands since that year, although it is not impossible that a few may be left on one of the uninhabited islands of that group.

It is known that fur seals continued to be killed about certain of the Channel Islands for many years after they were commercially exterminated at the Farallons, and at certain islands off Lower California as late as 1892. There is good reason to believe a few still persist about some of the isolated unfrequented islands whose rocky shores contain caves which the fur seals frequent and in which they may escape observation.

The fur seal which occurred on Guadalupe Island and, presumably, on the other islands off the coast of Lower California, was the Guadalupe fur seal (Artocephalus townsendi), a species distinct from the Alaska fur seal (Callorhinus alascanus) and, of course, distinct from the Russian and Japanese species (Callorhinus ursinus and Callorhinus curilensis). What the species was that frequented the Farallons and the other California islands is not certainly known, as there is no specimen in any museum. In all probability it was the same species as that found on the Lower California coast—the Guadalupe fur seal.

Fur seals were formerly abundant not only on the coast of California and Mexico, but in many other places further south. Among islands which they at one time frequented in large numbers may be mentioned the following:

1. *The Galapagos Islands.* Up to the beginning of the present century fur seals were abundant about these islands and a few are known to persist. Several were killed in 1905—1906, and recent reports indicate that enough remain to justify the belief that the herd can be restored. These islands belong to Ecuador and that country should be interested.

2. *Islands on the coast of Peru.* Among the islands on the coast of Peru where fur seals were once common are Lobos de Afuera and Lobos de Tierra. It is believed a few fur seals still remain in those waters.

3. *Chile.* At one time perhaps the largest fur-seal rookeries in the world were found on Mas-a-Tierra and Mas-a-Fuera of the Juan Fernandez group on the coast of Chile. Smaller herds occurred on other smaller islands off the southern end of Chile. In the early part of the last century millions of seals were killed in those waters and the herd was commercially wiped out. But it is now known that the

species was not actually exterminated. Dr. Carl Skottsberg of Gothenborg, Sweden, recently visited those islands and saw a number of fur seals, a few of which he collected as specimens. No doubt this important herd could be rehabilitated under proper international protection. Chile is the country most concerned.

4. *Uruguay.* There is a valuable herd of fur seals on Lobos Island in the mouth of the Plata River. This herd is protected by the Uruguayan government but it receives no international protection. Even Uruguay does not seem to realize what a valuable asset this herd can become.

5. *Falkland Islands.* The Fur-seal herd on these islands was once very large and valuable, many thousands having been killed in the early part of the last century. Although commercially depleted it is known enough seals remain to make restoration of the herd an easy matter.

6. *South Georgia.* These islands, situated in the South Atlantic east of the Falklands once had enormous herds of fur seals. Considerable numbers are said to be there.

7. *South Shetland.* These islands in the Antarctic just south of Cape Horn, in the early days, were the breeding grounds of large herds of fur seals and a good many are still left.

The Falklands, South Georgia and South Shetland islands all belong to Great Britain and that country should be deeply interested in rehabilitating the herds.

8. *New Zealand.* Fur seals are still found in some numbers on certain islands off the New Zealand coast, according to Mr. Le Suef, Superintendent of the zoological Park at Sydney.

9. *Australia.* Mr. Le Suef also reports that certain islands on the coast of Australia have remnants of the large fur seal herds that once frequented them.

10. *Kerguelen Islands.* A large herd of fur seals formerely resorted to these islands which lie southeast of the Cape of Good Hope. A remnant still remains and France, to which the islands belong, would no doubt be interested in restoring the herd.

In all probability there are small remnants of several other fur seal herds on several other isolated islands not included in the above list. There is every reason to believe that most if not all of these 15 to 20 herds can, through international protection, be restored to their former abundance.

SEA OTTER.

Like the three northern species of fur seals, the Northern Sea Otter (*Lataxlutris*) is fairly well protected by the fur seal treaty of 1911. But the Southern Sea Otter (*Lataxlueris nereis*) which occurs on the Southern California coast, receives no protection whatever except such as the State of California can give it within the three-mile limit. Nor is any protection afforded to sea otters in southern waters.

The early history of California makes frequent references to sea otters and sea-otter hunting. Indeed, for many years sea-otter and fur-seal hunting constituted almost the only industry on that coast. Sea-otter hunting began there at least as early as 1786, and the industry developed rapidly. Sea otters were found all along the coast from Trinidad Bay southward. They were particularly abundant about the Farallons, among the Channel Islands, and even in San Francisco Bay. They were abundant southward at least as far as the islands of Cedros and Natividad. One early manuscript (that of Vallejo) says: "They were so abundant in 1812 that they were killed by boatmen with their oars in passing through the kelp."

In 1812 the Russians began to explore the coast, islands and arms of San Francisco Bay. The records show that they gathered great numbers of sea-otter skins. It is said that, in some weeks they killed in San Francisco Bay alone as many as 700 to 800 sea otters a week. In a period of five years they took 50,000, and thereafter they took 5,000 a year down to 1831. One writer says that by 1817 the otter was exterminated from Trinidad Bay down to San Antonia Cove, near San Francisco, but that hunting continued more or less actively at various places along the coast farther south for years.

Some of the hunters hired Aleuts and bidarkas from the Russians, and Indians from Mission San Jose, and did quite a good business for some time.

Particular places where sea otters were taken in large numbers as mentioned in the old records were the Farallons, San Francisco Bay, Purisima, Monterey Bay, San Luis Obispo, Santa Barbara, San Buenaventura, San Diego, Todos Santos and San Quentin; and San Miguel Santa Barbara, Santa Cruz, Santa Catalina, San Clemente, San Nicolas, Coronados, San Benito and Cedros islands. Even as late as 1914 sea otters were occasionally killed about these islands, and it is known that a few still persist in certain favored localities.

While some of the early accounts are somewhat lacking in definiteness, and while there are many discrepancies, it

is nevertheless clear that both the fur and the sea otter were exceedingly abundant on the coasts of the Californias 100 years ago. The total number of otters killed between 1786 and 1868 must have exceeded 200,000. At current prices these would be worth at least $200,000,000, a very neat little sum.

The remarkable rapidity with which the Alaska fur-seal herd has increased during the last ten years under the protection of the fur-seal treaty of 1911, an increase from 127,000 in 1911 to more than 600,000 in 1921, which permitted a kill in 1922 of 30,000 seals valued at $1,500,000 net, demonstrates what a depleted natural resource of this kind will do when given proper protection through international cooperation. The world needs a similar but more comprehensive treaty covering, not only the other fur seals of the at present unprotected areas, but also the sea otters, elephant seals, whales, walruses, fishes and other natural resources of the sea. Such a treaty by the various countries interested would, in a few decades, result in rehabilitating these depleted resources to an extent that would permit for all time an annual product of at least $500,000,000.

Resolutions urging the necessity for early action by the various countries concerned have been passed by numerous organizations, including the Pan-Pacific Commercial Congress, the California Academy of Sciences, the Scripps Institution for Biological Research, the San Diego Museum of Natural History, the Los Angeles Museum, the Commonwealth Club of California, and the Chamber of Commerce of San Diego, Los Angeles, and San Francisco.

Such resolutions were adopted by the San Francisco Chamber of Commerce on January 23 last, and by the Western Society of Naturalists and the Pacific Fisheries Society at Los Angeles last September.

There is no greater or more urgent conservation problem than that of the natural resources of the sea which require international cooperation for their development and adequate protection.

It is hoped that our government may take the initiative to bring about an international treaty for the protection of these great natural resources.